



NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

**MERGING OF THE RECRUITMENT BRANCH AND THE
POLITICAL INFORMATION BRANCH OF THE GERMAN
ARMED FORCES AND APPLICATION OF THIS
RECRUITMENT NETWORK TO SAUDI ARABIA**

by

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March 2013

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ABSTRACT

The recruitment branch and the political information branch of the German Armed Forces have always been separated. Now, in times of a continuously shrinking budget and several ongoing reforms that include a massive reduction of the personnel body, we must rethink this structure. Merging these two branches would mean savings on the budget. Furthermore, we can assign the released personnel to other tasks, where the forces are in need of highly trained personnel.

This cost-benefit analysis evaluates the status quo exclusively for one German state, compares this status quo to possible alternatives, and gives recommendations for the future of the two branches. For the optimal distribution of staff and offices, this analysis employs optimization modeling.

We apply the resulting recruiting model to Saudi Arabia and assess the results based on that. Saudi Arabia is interested in potentially adopting the German system and we use the developed model to recommend the best recruiting locations in Saudi Arabia.

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LIST OF ACRONYMS AND ABBREVIATIONS

AOR	Area of Responsibility
EUR	Euro; European currency
GAMS	General Algebraic Modeling System
GPA	Grade Point Average
ID	Identifier; identification number for cities
IP	Integer Programming
KASP	King Abdullah Scholarship Program
km	Kilometer(s); distance in the metric system
LP	Linear Programming
MOHE	Ministry of Higher Education
NATO	North Atlantic Treaty Organization
PA	Public Affairs

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EXECUTIVE SUMMARY

The founding of the post-World War II German armed forces occurred on May 5, 1955, and included a personnel body of about 500,000 soldiers (including the Army, Navy, and Air Force) until the German reunification on October 3, 1990. Since that date, several reforms and restructuring measures have reduced the personnel strength to about 250,000 in total. The main reasons for this development were the result of a reduced threat to Germany and the armed forces' steadily declining budget.

The reduced budget is also the reason for the latest reform measures in the German armed forces. The Minister of Defense has the task of cutting eight billion Euros from his budget. Since personnel are one of the largest cost factors, the German armed forces is decreasing the number of soldiers, sailors and airmen to about 185,000. This diminution has effects on all branches of the German armed forces and compels us to rethink the structures of the individual branches.

In this thesis, we evaluated the recruiting and the political information branches of the German armed forces. Both branches are kept separate from each other, but focus on the same target group (young people between 16 and 24 years of age). While the recruitment branch is covering the personnel needs of the forces, the political information branch informs the target group and teaches about issues of security policy (e.g., tasks of the armed forces, German interests in Afghanistan, the North Atlantic Treaty Organization [NATO], etc.). The idea is to help save money by merging these branches, while simultaneously increasing the effectiveness of this newly formed, combined branch. By merging the branches, we could save money by reducing the personnel in the new branch and by reducing the amount of money spent on commuting and office rent. We can also increase effectiveness by restructuring both the lectures about recruiting/security policy and office recruitment talks (shortening them), which would allow for more lectures and talks, thus reaching a wider audience.

We conducted a cost-benefit analysis (limited to one German state) to evaluate the effectiveness of three main alternatives:

- first, maintaining the status quo, which means that the branches stay in their current structure, with separate offices for recruitment and political information, each led by one officer;
- second, merge the branches and enable the officers to lecture on both topics, which reduces the number of personnel and offices needed and thus saves money; and
- third, merge the branches, but keep the tasks divided, which means that every office would be staffed with two officers (one for recruitment and one for political information), which could still reduce the number of offices and officers needed, and also save money.

We used optimization modeling (Integer Programming [IP]) to minimize our expenditures for each alternative. The expenditures consist of the staff's monthly salaries, the money spent on commuting, and the money spent on office rent (in cities where we cannot rely on military installations). Our IP helped us to find locations for the offices where the expenditures are minimized.

In order to measure effectiveness, we created a lectures and a visitor value function. By doing so, we were able to draw a cost-effectiveness matrix that displays expenditures and effectiveness for each alternative in graphical form.

We must, however, always offset costs and effectiveness. We can increase effectiveness if we accept higher expenditures or we can lower expenditures, but have to accept diminished effectiveness. Thus, we had to answer the question of what is more important to us—expenditures or effectiveness.

Since the German population is declining (and, thus, the target group, too), the pool of recruitable young people is getting smaller. Moreover, since civilian firms are interested in high-quality personnel, too, the competition to

employ the best is getting stronger (“war for talents”). With this in mind, we decided that we have to favor the more effective solution when we recommend one alternative.

After using optimization modeling and calculating the effectiveness of each alternative, we obtained the following results:

- Maintaining the status quo results in expenditures of EUR 34,174.46 per month and an effectiveness of 0.61 on a scale of 0–1.
- Merging the branches where one officer is able to lecture on both topics results in expenditures of EUR 25,114.53 and an effectiveness of 0.5 on a scale of 0–1.
- Merging the branches and keeping the tasks divided within the branch results in expenditures of EUR 36,940.03 and an effectiveness of 0.595 on a scale of 0–1.

Referring to our philosophy to prefer the most effective solution (since we do not have a superior solution here that is the cheapest and most effective), we recommend maintaining the status quo. Although doing so is not the cheapest solution, it returns the highest rate of effectiveness. Since we compete for talent with civilian firms, we are convinced that we have to favor this solution.

The Saudi Arabian armed forces are facing a similar problem. An increasing number of colleges that offer free graduate education draw young people away from the armed forces that were previously the only providers of free higher education. This compels the armed forces to open a recruitment branch, which they did not need before because they always had enough volunteers without any recruiting efforts.

The German recruiting system is considered for application in Saudi Arabia. Although we do not need to merge branches there, we could use our model to help find the most cost-effective locations for recruitment offices. We limited our model exclusively to the province of Makkah, with eight major cities.

Since recruitment lectures do not currently exist, different levels of effectiveness cannot be assessed, so we have to assume equal effectiveness for each possible solution, regardless of how many recruiting offices we need and where we locate them. Thus, we solely focused on cost as the driving factor.

After solving with our optimization model, we recommend opening recruiting offices in Makkah, Jeddah (also responsible for Rabigh), Ta'If (also responsible for Al Khurmah), Al Qunfudhah, and Ranyah. This means that we need to locate recruiting offices in six of the province's eight cities. The associated cost for this solution is EUR 40,165.72, which is the lowest cost of all the examined alternatives. Thus, we recommend opening recruiting offices in the aforementioned cities.

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I. INTRODUCTION

The German armed forces are facing reform, resulting in a personnel reduction from about 250,000 down to 185,000. This is not the first reduction since the German Reunification in 1990, and every subsequent reduction results in a retreat of the German armed forces from the area in which they were originally based. This means less representation in public. Even now, there are regions in Germany where the armed forces are no longer present. With the Minister of Defense's deployment decision (made on October 26, 2011), these "empty" regions will become even more numerous and larger, since the number of bases will be reduced from 398 to 324. The danger of this retreat is that the people living in these abandoned areas will forget the armed forces and the service that they provide to the country. People in uniform are no longer a part of civilian life and those serving in the armed forces will be more of an exception to everyday life. The only active soldiers left in these "remote" areas are the teams from the career centers and the political information officers. Here, they become "Mr./Mrs. Armed Forces," the only links between the public and the military.

The second problem is that the recruitment branch and the political information branch are completely independent from each other. Although this is not an initial problem for them, the retreat might cause more competition, since both branches are focused on the same target group. We explain this relationship in Sections II.A and II.B. Currently, recruitment officers and political information officers perform their respective jobs independently from each other. During the last ten years, some cooperation has evolved on the working level, but this was based more on the empathy of the individuals involved, rather than the result of any strategic alliance. The problem is not the independence of the branches themselves, but rather the target group of the two branches: pupils aged 16 and over and teachers. The public (including pupils and teachers) does not differentiate between the members of the two branches. For them, they are talking to representatives of the armed forces, no matter what branch he/she is

from. Thus, when there is no cooperation between the actors, the invitation of one of them to a school will automatically close the door for the other at the same school for some period.

The third problem that favors merging the branches is that once in a lecture, neither the recruitment officer nor the political information officer can control the questions arising from the pupils. This means that the recruitment officer must be capable of answering questions concerning security policy (e.g., what the armed forces does in Afghanistan) and vice versa, as the political information officer must answer questions about career opportunities in the armed forces. This means that both must have at least a basic knowledge about the other's topics.

Merging the two branches could solve the above-described problems and contribute to the necessary reduction of the armed forces and budgetary savings. By merging the recruitment and political information branches, we can reduce the current competition, and possibly avoid it altogether. This means that the target group will have one contact in the armed forces for both recruitment and security policy questions. This also reduces confusion among the target group and makes it easier for them to get in contact with the armed forces.

Furthermore, we can save money because merging those branches will make some of the current recruitment/political information offices redundant. Since some of these offices use rented space, the rent costs can be eliminated for those offices that are no longer needed.

In addition, the personnel requirements in this new branch will be less, which also results in lower costs. Instead, the released personnel can be assigned to other segments of the armed forces that are in urgent need of more personnel.

Recruitment officers regularly hold more than 200 lectures per year, while political information officers make fewer than 100. These numbers show that, first, recruitment lectures are far more in demand and, second, that by improving

time management, personnel can be freed up for other parts of the forces since we need fewer officers when we improve time management.

Last, but not least, the training for recruitment and political information officers is only different in terms of the main topic (political information or recruitment). Media training, argumentation training, as well as minor topics, is the same. Thus, by prolonging the training by approximately 1½ weeks, we can train these officers to perform the duties of both positions. Knowledge about the other's segment is crucial because during lectures they have to answer questions about the other topic. Thus, we can use this fact to stress the importance of their training, so that they perform optimally during lectures. Therefore, when the officers are able to perform both jobs, there would be no need to keep the branches separated.

We have to recognize, however, that the actual amount of money saved, the number of personnel to be released, and the most effective deployment of offices can only be obtained by conducting a cost-benefit analysis. Since the volume of this analysis for the whole of Germany would exceed the extent of a master's thesis, we are going to focus exclusively on only one of the 16 German states.

We will also extend the model to check its applicability in other environments. We have chosen Saudi Arabia as an example. The Saudi armed forces had its golden age with respect to recruiting in the '90s and it lasted until 2005/2006. In the aftermath of Operation "Desert Storm" to free Kuwait from the Iraqi occupation, the Saudi armed forces "enjoyed" the benefits of both an economic decline, where high unemployment rates made military opportunities more valuable, and the patriotic spirit that allowed for the recruiting of the best applicants available. Since the applicants targeted by the armed forces are mainly high school graduates, the competition for this pool was mainly from universities and colleges. High school graduates tend to join universities whenever possible to enjoy the free education, as well as the generous incentives provided by the government to the universities (e.g., free housing, free

books, and a monthly allowance for each student—such are the conditions for students in Saudi Arabia). Because seats were limited for the only seven universities in the country, however, many high school graduates were forced to look for alternatives, and joining the service was one of the best alternatives available for them.

Furthermore, the only measure of adequacy for graduate admission was the high school grade point average (GPA), which was not enough to ensure the quality of the applicants since it did not control for an important factor—ability. This fact added more high-quality applicants to the pool available to the armed forces to choose from, since they were not chosen by the universities.

In more recent years, it appears that the country's rapid economic growth, associated with heavy investments by the government in establishing new universities as well as the growing private sector investments driven by incentives provided by the government, may pose enormous challenges for the armed forces' recruiting efforts. In the past few years, the percentage of high school graduates who joined colleges for associate or baccalaureate degrees jumped remarkably. According to the Ministry of Higher Education (MOHE) statistical center, 71% of high school graduates were admitted to colleges in 2005 (MOHE, 2012). This percentage jumped to 86% in 2010 (see Figure 1).

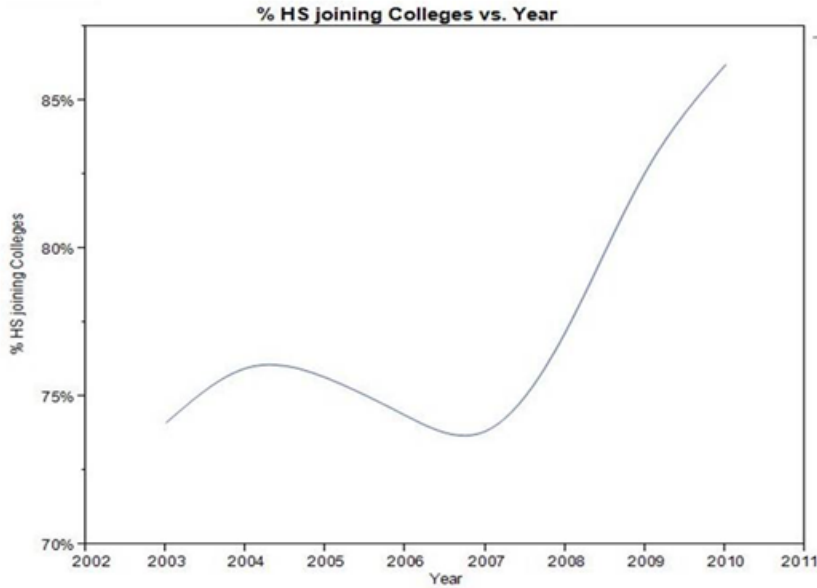


Figure 1. Percentage of High School Graduates joining colleges (After MOHE, 2012).

The Saudi government invested heavily in higher education (both undergraduate and graduate education) in the past five years, raising the number of colleges available for Saudi students from 334 in 2005 to 608 in 2010 (MOHE, 2012). Furthermore, a scholarship program was initiated in 2005 (MOHE, King Abdullah Scholarship Program [KASP], 2011) to provide graduate and postgraduate education for Saudi students in 22 countries other than the Arabic countries.

Regarding these numbers and our expectations of the near future when the new universities start to operate in full capacity, it is more likely that the pool of applicants available to Saudi military recruiters will shrink and that the quality will be degraded as well. Due to classification issues, we are not able to provide data about the numbers and quality of the applicants to the service, but the competition can give a general idea of how recruiting efforts and military training institutes have suffered, and will continue to suffer in the near future, from the low numbers of new applicants and their poor quality.

Solutions to this issue can involve different measures such as improving the pay system, educational benefits while in the service, scholarships provided

by the military, and improving the recruiting and advertisement process of the armed forces. Since studying the first three proposed solutions is beyond the scope of this thesis, we are going to investigate the possibility of applying the German recruiting model to the Saudi armed forces recruiting system.

The Saudi armed forces recruiting process is completely separate for each of its branches (Army, Air Force, Navy, and Air Defense). Each branch conducts this process with no association with systematic advertisement efforts or any attempts to raise public awareness of the opportunities provided by that branch. Public Affairs (PA) offices in each branch are only doing a responsive role with respect to media interaction only and with no or minimal involvement in local communities, especially at schools and youth events.

The status quo in Germany is not applicable in Saudi Arabia since PA offices do not conduct any efforts in the field and do not interact with local communities. We will apply the resulting model from combining both recruiting and political information offices into one office.

II. PROBLEM BACKGROUND—GERMAN MILITARY

In this chapter, we analyze the tasks and problems of the recruitment branch and the political information branch in Germany. First, we expound on the tasks of the recruitment branch and, then on the tasks of the political information branch. In a third step, we explain the problems that arise from those tasks with respect to actual developments in the German armed forces.

A. TASKS OF THE RECRUITMENT BRANCH

The primary focus of the recruitment branch is to gain new personnel for the active service in the German armed forces, but it also includes the testing of people interested in the reserve force. To attain the target, there are five recruitment centers: North, South, East and West, plus one for Navy personnel only. Since the deployment decision of the Minister of Defense on October 26, 2011, which significantly reduces the German armed forces, these recruitment centers are now called career centers (Sachstand zur Neuausrichtung..., 2011). These career centers seek prospective candidates for all branches of the armed forces—Navy, Air Force, Army, and Medical Service. Within each area of responsibility, these specialized centers (excluding the one for the Navy that is used for testing only) maintain recruitment offices that are usually led by a recruitment officer in the rank of a lieutenant junior grade or lieutenant (O-1 or O-2). The officers generally lead two to three (sometimes four) chief petty officers (high-ranked [E7 and above] petty officers of the Army, Navy or Air Force).

The recruitment officers are “in the field” within their respective geographic areas of responsibility and address young people with the goal of gaining heightened interest in serving in the German armed forces. This is done by maintaining booths at fairs or job exhibitions, but mainly by giving lectures in schools, focusing on high schools and middle schools. During each lecture, the

recruitment officer describes different career opportunities, including the liabilities that arise from voluntary service in the armed forces.

Once the prospects become interested, they are scheduled an appointment with one of the recruitment chief petty officers. The assigned petty officer then goes into detail based on the applicant's skills and offers a personalized military and educational career plan. With this offer, the applicant can decide whether or not to turn in an application form. Once the applicant applies, he or she is tested in one of the five centers.

B. TASKS OF THE POLITICAL INFORMATION BRANCH

Political information officers (there are currently 94 with the rank of captain [Jugendoffiziere, 2012]) are experts in security policy; therefore, they are part of the public relations branch of the German armed forces. Under the extended concept of security, they also address aspects of social, environmental, and developmental policy. Their main objective is to portray Germany's security policy to interested segments of the population (especially pupils and teachers). In their lectures, they mostly inform students and teachers about the German contribution to international conflict prevention and crisis management, in addition to the progress, perspectives, and difficulties of German missions abroad.

Lectures in schools, in consultation with the teacher, usually have a political or historical reference (specifically in politics, social studies, history, religion, or ethics) (Schnittker, 2011). These topics enable some dialogue with the pupils about peace, liberty, and security.

Political information officers also invite pupils of higher grades to an interactive simulation game about politics and international security. The game simulates the national and international relationships between politics, economy, environment, and security.

C. PROBLEMS ARISING FROM THE TASKS OF THE TWO BRANCHES

As outlined in the Introduction, the German armed forces are being reformed, resulting in a personnel decline from about 250,000 to 185,000 (Sachstand zur Neuausrichtung..., 2011). This is not the first reduction since the German Reunification in 1990, and every subsequent reduction results in a retreat of the German armed forces from the area in which they were originally based. This means less representation in public. Even now, there are regions in Germany where the armed forces are no longer present. With the Minister of Defense's deployment decision (made on October 26, 2011), these "empty" regions will become even more numerous and larger, since the number of bases will be reduced from 398 to 324. The danger of this retreat is that the people living in these abandoned areas will forget the armed forces and the service that they provide to the country. People in uniform are no longer a part of civilian life and those serving in the armed forces will be more of an exception to everyday life. The only active soldiers left in these "remote" areas are the teams from the career centers and the political information officers. Here, they become "Mr./Mrs. Armed Forces," the only links between the public and the military.

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III. METHODOLOGY

In this chapter, we introduce the methodology we use to measure the cost-effectiveness of merging the recruitment branch and the political information branch. First, we set the frame for the cost-benefit analysis and, second, we take a theoretical look into the instrument we are using to set up a new and combined branch: optimization modeling.

A. COST-BENEFIT ANALYSIS

A cost-benefit analysis consists of various steps that we explain in the following section. We start with the goals and objectives of the cost-benefit analysis and then we state the possible alternatives to merging the two branches. Then, we introduce the constraints we might be facing, followed by the assumptions we have to make in order to conduct the analysis. Additionally, we evaluate potential consequences and look at the evaluation criteria, their measurement, and their relation to the goals and objectives of the analysis. Lastly, we talk about the criteria weighting and relevant costs.

1. Goals and Objectives

With respect to the background presented (the cuts in the defense budget and the resulting decline in personnel strength) and the problems the two branches are facing, the goal is to save money, while becoming more effective at the same time. This means that we must address the problems discussed in Chapter II.C. In short, this means that we are seeking to improve effectiveness and to reduce costs. Thus, we need to rethink the structure of the two branches. The proposed way to attain the listed goals is merge the two branches into a combined “career and political information branch.” Individual officers will then no longer perform recruitment and political information duties separately. Through advanced training, we can ensure that the personnel in this newly formed branch are capable of addressing both recruitment and political topics. The training for the two branches already takes place in the same school and some content (like

handling the media) are even the same. Thus, the advanced training for the new branch will be longer (to cover all recruitment and political topics), but the duplicate contents only need to be taught once. A prolongation of this course from three weeks to five weeks appears to be reasonable in order to cover all the needed topics.

By enabling the personnel of the reformed branch to cover recruitment and political topics, we ensure that they can competently answer all questions arising from pupils. Furthermore, with only one person offering lectures on both topics and addressing the target group, we avoid the double structure. In addition, teachers only have one contact person for either topic.

We can often observe, however, that some teachers resent having to invite a recruiting officer into their class because they do not want a soldier offering career opportunities to their pupils. This might cause potential problems for the political information portion that these officers offer. An additional problem is that some officers cannot differentiate between the topics that they were invited to speak about and then recruitment issues can take over. Consequently, careful selection and education of these officers is necessary.

Merging the two branches also means that we can rethink the number of personnel working in them. Since we increased the workload for the individuals in the new branch, the workload should be evaluated in order to assess the level and quantity of the work involved. Furthermore, we must review the contemporaneous areas of responsibility to find the best deployment structure for the new combined branch. We expect to be able to reduce the number of personnel working in the new branch. The absolute number of personnel working (and, thus, also the number of the personnel to be released) is the subject of our analysis in Chapter IV. The reduction of personnel in the new branch leads to a reduction in the money spent on personnel in this branch. We can assign the released personnel to other parts of the armed forces where they are needed. Due to their enhanced responsibilities, however, the ranks of the officers remaining in the combined branch should be increased to the rank of captain,

which leads to an increase in costs. Thus, the money saved by reducing the number of personnel in this branch should be offset with the money spent by increasing the officers' ranks. To be cost effective, the amount of money must not exceed the actual amount of money currently spent on personnel.

On this point, we have to mention that reducing the personnel of the new combined branch does not instantly save money because we assign the personnel to other tasks. All personnel in the German armed forces, however, receive their salary from the same department and German officers usually serve in the armed forces for 13 years (unless they choose to become professionals). At the same time that we assign the personnel released by the merger to other duties, other officers reach the end of their service time. By not recruiting new officers to replace these officers, we achieve the savings in personnel costs.

Bottom line, the objectives to achieve the above goals are to try to minimize expenditures and maximize target group contacts.

In further discussion, we will focus on the officers of the two branches, because they are the mainly ones approaching the target group. We are aware that recruiting offices are also staffed with chief petty officers (generally, two per office). Since these chief petty officers impose a cost, we will respect them when it comes to the personnel endowment of the career and political information offices.

2. Alternatives

To obtain the best results for the armed forces by performing this cost-benefit analysis, the suggested new "career and political information" branch should be compared to the possible alternatives. There are, however, only few alternatives to the previously described solution.

a. Maintaining the Old Structure

One possible alternative is to maintain the old structure, hence make no changes. The separation of the two branches remains, with a clear differentiation between their tasks. There will be no reduction in personnel; thus,

no budgetary relief. The above-described problems will remain the same. By maintaining the old structure, however, we avoid the problem of some teachers refusing to invite a recruiting officer into their class because they do not want the armed forces to “advertise” in schools.

b. Merging to One Branch with Divided Tasks within the Branch

The second alternative is to merge the two branches into one “career and political information” branch, but to keep the tasks separated within the branch. This ensures that there is only one contact person for lecture requests, but it still keeps the different tasks strictly separated. This, too, avoids the argument of some teachers that they do not want to invite recruitment officers into their classes because they do not want the armed forces to “advertise” in schools.

This approach, however, does not relieve supernumerary personnel and, still, the actors—career officers as well as political information officers—have to have knowledge about the other’s specialty. Bottom line, this alternative changes the outer structure, while the inner structure remains unchanged. Thus, alternative two is very similar to alternative one, although it might save some overhead costs (e.g., rent).

3. Constraints

There are no budgetary constraints related to merging the two branches into one. Rather, this merge saves money from the armed forces budget.

There is, however, some resentment in the public relations branch, to which the political information officers belong. The political information branch wants to be clearly distinguished from the career branch. The public relations branch puts value on the fact that political information officers only deal with security policy without making any recruitment efforts. The fear is that merging the branches and assigning double functions effaces the lines between recruiting and political information, subsequently making it impossible to teach security

policy at schools (with respect to the difficulties laid out above concerning restraints from some teachers). As a result, we never questioned the differentiation between these branches.

Another argument is the German law restricting access of the recruitment officers to schools. The German Constitution allows access to schools for the career branch solely to inform about the mandatory military service, which only concerns young males. Only by informing about this mandatory service does the recruitment branch have access to schools. Unfortunately, Germany abandoned this mandatory military service in 2011, so there is only voluntary military service left. Therefore, it became harder for the recruitment branch to lecture in classes. The only possibilities to enter schools now are by invitation or by an amendment of the Constitution that gives the military the right to enter schools.

A shrinking overall defense budget, however, forces us to think in new ways and to consider new possibilities to establish an effective structure for the future. In addition to budget constraints, the age structure of the German population will change dramatically within the next 28 years, trending towards an increase in the number of elderly people and a shrinking younger generation, as seen in Figure 2.

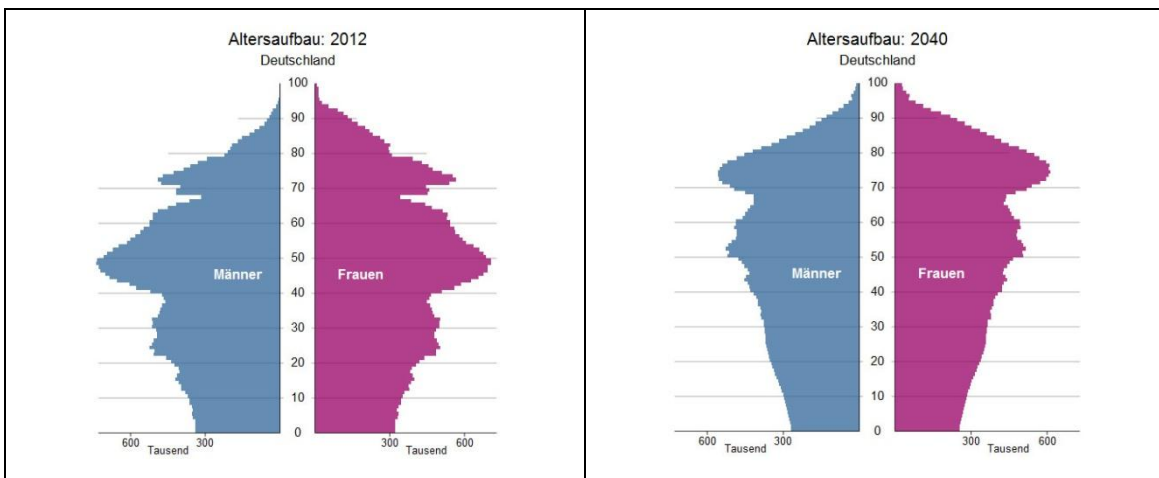


Figure 2. Age Structure in Germany, 2012 and 2040 (From Federal Statistical Office Germany, 2012).

From the recruiting point of view, this means that the basis to recruit from is getting smaller and smaller. The positions in the armed forces have to be occupied, however, particularly important and sensitive duties in units that are deploying abroad. Considering this fact, it is obvious that these key positions can and should be occupied by releasing personnel internally and assigning them to these positions. By merging the career branch and political information branch, these organizations can contribute their part to the restructure of the armed forces.

4. Assumptions

The first assumption made is that all people involved in this merger are willing to accept this to improve the efficiency and cost-effectiveness of these sectors of the armed forces. They see the necessity for this step and they actively support it. To reach that goal, we must implement measures that ensure this active support (e.g., information and discussion forums).

Second, there are no restraints on the future disposition of the combined career/political information offices. They can be based either within military bases (relying on military infrastructure) or, where necessary or appropriate, outside military bases in rented offices. The last option is to be preferred to ensure optimum visitor traffic for the career part of the new branch.

The second assumption automatically leads to the third; namely, that money is released out of the budget to execute the merging of the branches, including money for rented office space as well as for the promotion of some officers.

Fourth, we assume that the public, specifically teachers, recognizes the new structure (i.e., accepts it) and can differentiate between the offered topics. Furthermore, we also assume that these teachers trust the invited officer to talk only about the topic he/she was invited to present.

Fifth, we assume that the German Parliament changes the Basic Law, allowing lectures about the voluntary military service in schools in the future.

Finally, we assume that the soldiers chosen to serve in this new branch are actively keeping themselves up to date, especially in all topics related to security policy. To support this, we should continue with regular advanced education in this topic at least once or twice a year.

Without meeting these assumptions, the transformation would not be effective and would result in even more problems that would have to be solved.

5. Potential Consequences

One unintended consequence is that it is hard for the officers serving in the double function in this new branch to differentiate between the topics that they have been invited for at schools or exhibitions. This issue can harm the trust that students and teachers have towards these officers, specifically when it comes to recruiting issues. Still, many people (specifically those of the “68 generation” who promote peace and are against everything that could be related to the military) are reserved towards the armed forces and they refuse to deal with them in any way. Thus, the branch officers have to be carefully trained to differentiate between the topics. We can achieve this by regular advanced education as a part of conference attendance. Such conferences already exist within the different branches, so there is no need to regard this issue any further within this analysis.

Another unintended consequence is that the organization becomes less effective after the merging of the two branches. This ineffectiveness can result from longer commuting times to the jobs, too few personnel trying to match too much demand, or insufficiently trained personnel. We can disregard the training in the analysis because it is prior to the job assignment. We must ensure, however, that this training contains all the necessary topics to successfully fulfill the duties of career and political information officers, as well as ensuring further advanced education. Commuting times and demand, however, have to be

included in this analysis. Commuting times to and from jobs can make up an important percentage of the daily work. Thus, we must keep these commuting times as short as possible, since they restrain the travelling officer from other duties. With respect to this, we must evaluate the average travel times and consider them in this analysis. Lecture offers not meeting the demand are the result of an ineffective preparation. Thus, the number of lectures held is part of the evaluation, including the average length of a lecture. We have to connect them with the commuting times to find the average duration of a job, which can then be taken as a basis to find the optimal future deployment of the career and political information offices.

6. Criteria, their Relation to Goals/Objectives, and their Measurement

In order to attain the overall goal (improved effectiveness) we introduced two objectives. These objectives are very vague, however, and need to be clarified. By doing this, we get down to measurable criteria that describe these objectives.

a. Reduce Expenditures

The criteria assembled here focus on the impact that recruiting and political information activity has on the budget of the existing branches or the proposed branch.

(1) Reduce Ineffective Offices. Ineffective offices are offices that do not or cannot use their work time effectively. A reason for this is that, due to population density and development, there are not enough pupils in the age of the target group within the area of responsibility. Thus, the number of visitors to the office, workload in hours, or the population density and development of the target group age (16+ years) in the area of responsibility can measure ineffectiveness. We decide, however, to measure the amount of money spent on operating offices of the new combined branch because it allows us to observe a monetary value, where the lower means the better.

(2) Reduce Expenditures on Office Rent. Usually career and political information offices are located within military areas, but a number of them also use rented space within other governmental or civilian offices (e.g., within the agency for employment). By merging the branches, some of these offices will no longer be necessary. Thus, a good measure is the amount of Euros (EUR, €) spent on rent, where the less, the better.

(3) Reduce Personnel. Personnel are one of the biggest cost drivers. Thus, reducing personnel will save a lot of money in the budget. Since we can easily track the amount of money we spend on personnel to the number of soldiers working in the branch, the number of officers and their rank is a good measure for the amount of Euros spent on them. We suggested, however, equaling the ranks between the remaining officers when merging the branches, which implies an increase in cost, while simultaneously reducing personnel. We respect both values by choosing the overall amount of money spent on officers for our evaluation. This can be derived by the sum of officers in the different ranks multiplied by their according rank salary. The less personnel costs, the better.

(4) Reduce Expenditures for Commuting. Traveling to lectures and exhibitions and back can involve a lot of time that could be used for other things. Even more, traveling costs gas and sometimes hotel charges. Thus, we must keep travel time as short as possible. The best comparable measure here are the distances between the individual cities (going there and returning, according to the number of schools of interest) multiplied with the standard amount per kilometer (actually EUR 0.42). This standard amount is the accepted expenditure for traveling one kilometer in Germany. The less money spent on commuting, the better.

(5) Reduce the Amount Spent on Exhibitions. Exhibitions are an important opportunity to address people of the target group. They are usually expensive, however, and have a significant impact on the budget. Thus, we should reduce these expenditures as much as possible. Here, the amount of

Euros spent on exhibitions can serve as a measure. We assume, however, that the amount spent on official exhibitions will be the same for all alternatives. Thus, we can disregard this criterion for further analysis.

Since we want to minimize costs, the total costs would then be calculated as:

Commuting Costs + Rental Costs + Personnel Costs

$$\sum_{i=1}^{25} \sum_{j=1}^{25} D_{i,j} S_{i,j} + \sum_{j=1}^{25} R_j C_j + \sum_{j=1}^{25} P_j C_j \quad (1a)$$

By minimizing this cost function, we expect to find the optimal solution; thus, the location of offices from which the expenses for commuting are the lowest.

b. Increase Target Group Contacts

All three branches—the career, the political information, and the proposed combined branch—focus on the target group, which includes young people, ages 16 to 24. Contacting this group of people has to be maximized to attain best results.

(1) Increase Lectures. Lectures about career opportunities and security policy are the core of the branches; thus, as many lectures as possible should be held. The total number of lectures held by all officers in Schleswig-Holstein (the German state to which we limit our analysis) per year serves well as a measure because we have sufficient data to compare the performance before (the status quo) and after merging the branches. The more lectures held, the better. We recognize at this point that the number of lectures depends on the number of invitations into schools. Officers however, can control this to a certain extent by building up relationships with teachers.

(2) Increase Exhibitions. Exhibitions are as important as lectures to reach the target group. Thus, all efforts have to be taken to participate in as many exhibitions as possible. It is important to notice that this point does not contradict the point about “minimize the amount spent on exhibitions.” We

can still assume that the amount spent for official exhibitions, like job markets, is the same for all alternatives, since the central event marketing coordinates them. There are many exhibitions, however, that can be performed free of charge (e.g., by maintaining information booths at schools). Thus, we can increase the number of exhibitions at schools, while keeping the amount spent for exhibitions on the same level or even reducing it. The advantage is that we are able to capture those pupils that did not attend the recruiting lecture. The measure for this is the number of exhibitions (information booths) performed per year. The problem is that recruiting officers are not allowed to simply put up an information booth at a school. They need permission from the school's principal. We can try to increase the exhibitions by always putting up an information booth whenever an officer performs a lecture, but because we need the principal's permission, we cannot be sure that we will always be able to do so. Because a person outside the armed forces that we cannot influence makes the final decision, we cannot build a scenario on how to maximize the exhibitions in schools. We can only strongly suggest to always try putting up an information booth, but we are not sure whether we can obtain permission or not. Thus, we must assume that recruiting officers always try to connect an information booth with a lecture and that this is the same for all alternatives. Therefore, we will not regard the number of exhibitions any further.

(3) Increase Visitors to Offices. Especially for the career branch, the offices are important to informing young people about career opportunities. In order to not only have scheduled visitors (from exhibitions or schools), but to also welcome walk-in visitors, these offices should be located where they can easily be reached and accessed, preferably without the restrictions that occur when entering a military base. Here, we can apply different measures. First, the population density and the number of people in the target group in the area and, second, the number of visitors to the office. For the purpose of this analysis, we will employ the last measure because we can shorten the time needed for information talks, which allows us to process more

visitors through the offices. The more visitors we can handle, the better. We have to mention here that applications for service in the armed forces exceed 60,000 each year, which is more than the recruitment offices can currently handle in total (40,000). Thus, we do not face the problem of low demand by reducing the time needed for the information talks.

(4) Increase Media Presence. To reach the target group in a broad manner, media presence is vital and helps with being visible to the public. By advertising in the media, the focus of the target group can be drawn onto the armed forces and enhance target group contacts. Thus, we must maximize the armed forces' presence in the media. The measures here are the number of newspaper ads, the number of TV spots, and the number of radio spots.

The number of ads in the media, however, will be the same for all alternatives. Thus, we will not consider media presence in the analysis, because there is no difference in the media presence between the alternatives.

7. Criteria Valuing, Weighting, and Relevant Costs

In order to consider multiple criteria in our analysis, we must value and weigh the criteria to assign a certain importance to them. This process is dependent on the decision-maker's preferences; in this case, our preferences. We might opt to focus more on cost savings than on an increase in target group contacts, for example.

Note that expenditures are considered separately from effectiveness. We compare the expenditures against each other. Although we value all measures, we only weigh the effectiveness measures. For completeness, we shortly discuss the relevant costs in this section.

a. Criteria Valuing and Weighting

We value the importance of the different criteria on a scale ranging from 0 to 10, where 0 is the least important and 10 is the most important. Each criterion will be assigned a value within this range. The different values assigned will be added and result in a denominator. The numerator is the specific value

assigned to the criterion. The result of this division will return a value between 0 and 1, the weight for this criterion.

With respect to the overall effectiveness (pertaining to target group contacts), the criteria of “increase lectures” and “increase visitors to offices” are both significantly and equally important, because they both reflect direct contacts to the target group. Thus, we assign the same highest value (10) to both of these criteria.

These individual values sum up to 20. To find the weight, we are going to divide the individual values by their sum. This returns the following weights:

Increase lectures:	10/20=	0.5
Increase visitors to offices:	10/20=	0.5

Now that we found the weights, the criteria above have to be valued individually. Hence, a value function is set up for each of them. This value function can be approximated with a linear function and allows for comparing the attributes over their respective ranges by translating them into a value between 0 and 1. The formula for this calculation is

$$\frac{\text{Measure} - \text{not.enough}}{\text{good.enough} - \text{not.enough}}$$

The key data for “Increase Lectures” are <560 (not enough) for all officers in Schleswig-Holstein and 1,200 (good enough), respectively. These values indicate that for every value below 560, a 0 (zero) will be assigned, and for every value equal to or over 1,200, a 1 will be assigned. For any number of lectures between these numbers we can find the value by plugging the measure into the formula above.

“Increase Visitors to Offices” is measured in the number of visitors per day per recruiter to the career offices. Here, “not enough” is <4, “good enough” is 7 per day and recruiter. For example, when we measure five visitors

per recruiter, we enter these values in the equation above and receive an effectiveness of $(5-4)/(7-4) = 0.33$.

b. Relevant Costs

There are two types of relevant costs. First, there are nonpermanent costs that arise from merging the branches. These costs emerge from moving offices to another location or from closing down offices and moving material. These costs appear only at the time of merging the branches and will have a short-term impact on the budget. In the long run, these costs will not appear again. We must consider these costs, however, in the analysis for the alternatives, including moving offices and personnel from one location to the other. Thus, they will become part of the “minimize expenditure” part of the analysis.

Permanent costs, on the other hand, include the rent for new offices, and the amount of money spent on salaries and commuting. These costs are expenditures in the long run and we have to respect them in the analysis. For this analysis, the permanent costs consist of the monthly office rent (EUR 912.25) where applicable, the monthly expenditures for salaries (for officers and chief petty officers), and the expenditures for commuting (currently 0.42 Eurocents per kilometer).

According to Professor Charles LaCivita (2011), the expenditures are not weighted, as we explained above. We have to calculate them, however, and we display them in the x-axis of the decision matrix.

The overall expenditures are the sum of all sub objectives in the category “reduce expenditures.”

B. OPTIMIZATION MODELING

1. Overview

Decision modeling is defined as “the development of a *model* (usually mathematical) of a real-world problem scenario or environment (Balakrishnan,

Render, & Stair, 2007, p. 2).” Using such models enhances the capability of proper decision making, since we can manage to quantify certain variables affecting the decision-making process in order to illustrate the optimal solutions to our managerial problems. Optimization modeling is one part of the decision modeling. Due to the limited resources available, usually, for managers and decision makers in the normal environment, it is critical to ensure the optimal use of resources to maximize profit, minimize costs, or even to effectively specify certain needs that can be quantified.

Common types of optimization models are Linear Programming (LP) models, Integer Programming (IP) models, Nonlinear Programming models, and Multi-objective Programming models (Balakrishnan, Render, & Stair, 2007). LP is the most common technique and is defined as the “mathematical task of maximizing or minimizing a linear form whose variables were restricted to values satisfying a system of linear constraints (Glicksman, 1963, p. 1),” while Nonlinear Programming involves nonlinear variables and/or constraints. In situations such as defining how many ships to build or engines to assemble, we cannot obtain solutions in fractions, so we use IP instead. The goal is to define and formulate all the decision variables and the constraints along with the objective function, and then to transform all of these elements into algebraic form. Combining all described elements of the model provides a feasible solution to the problem, if such a solution exists. Due to our need to include both integer variables and binary variables (variables that take values of 0 and 1 only), we use the Integer Programming technique to decide where to locate recruiting offices and what cities will be served by which office in order to minimize the commuting costs. We also respect, however, the amount of money we have to spend on office rent. While we can rely on military installations in most cities, we have to rent office space in other cities. These expenditures can affect the decision of whether to open an office in any given city or not.

2. Integer Programming (IP)

Although LP would provide results by displaying the precise values required by the model, it is more common to require integer numbers when making decisions in the business world. For example, to figure out how many trucks are required to move cargo from one point to another, a manager would not accept 3.5 as an answer.

Another important issue is whether to take a course of action or not. The decision variable then becomes a binary one, taking a value of either 1 or 0. We must recognize, however, that IP might not provide the same solution that LP would provide. Thus, we have the possibility of obtaining a solution that is as close to optimal as possible, respecting all given constraints. We call this the optimal solution.

In our decision of whether or not to merge the branches into one branch, we also need to answer the questions of if and where to open or keep an office of this new branch. Our purpose is to find the most cost-effective locations. Thus, we have to answer a yes/no question and IP offers the best possibilities to do so (as lined out in the truck example above). The money we need to spend on personnel, commuting expenses, and office rent is part of the objective function. We explain the complete setup of the cost-benefit analysis in the following chapter.

IV. COST-BENEFIT ANALYSIS

In this chapter, we conduct the cost-benefit analysis by employing the theoretic structure we described earlier. After describing the status quo, we examine the alternatives. We then compare the status quo and all alternatives against each other and conduct a sensitivity analysis by changing assumptions and constraints.

Schleswig-Holstein is the northernmost German state, bordering Denmark in the north and the states of Hamburg, Mecklenburg-Vorpommern, and Lower Saxony in the south. In the west and in the east it is surrounded by the North Sea and the Baltic Sea, respectively. In 2010, the overall population was 2,834,259 people, of which 254,507 belonged to the 16–24 target age group. The population statistic, however, predicts a decline in the overall population down to 2,789,000 people, of which an anticipated 194,874 people will belong to the target group (all data: Statistical Office Hamburg/Schleswig-Holstein, 2010). This prediction implies that the target group in this state will decline significantly, by 23.43% (for all data, see Table 1).

County ID	County	2010			2025			Change in Target Group	
		Target Group	Population	% Target Group	Target Group	Population	% Target Group	Total	%
4	Rendsburg-Eckernförde	24,094	269,778	8.93%	19,345	258,700	7.48%	-4,749	-19.71%
5	Kiel	25,267	239,526	10.55%	15,266	248,200	6.15%	-10,001	-39.58%
6	Dithmarschen	12,258	134,798	9.09%	9,116	125,600	7.26%	-3,142	-25.63%
7	Steinburg	12,473	132,897	9.39%	8,981	123,200	7.29%	-3,492	-28.00%
8	Neumünster	7,759	76,830	10.10%	5,477	70,600	7.76%	-2,282	-29.41%
9	Plön	11,011	134,291	8.20%	8,457	126,800	6.67%	-2,554	-23.19%
10	Ostholstein	16,410	204,454	8.03%	12,261	197,500	6.21%	-4,149	-25.28%
11	Segeberg	22,137	259,200	8.54%	18,910	257,200	7.35%	-3,227	-14.58%
12	Pinneberg	25,489	303,481	8.40%	21,795	309,000	7.05%	-3,694	-14.49%
13	Lübeck	19,777	210,232	9.41%	13,894	202,900	6.85%	-5,883	-29.75%
14	Stormarn	18,168	229,756	7.91%	16,791	240,500	6.98%	-1,377	-7.58%
15	Herzogtum Lauenburg	16,044	186,874	8.59%	13,631	184,400	7.39%	-2,413	-15.04%
Total		254,507	2,834,259	8.98%	194,874	2,789,000	6.99%	-59,633	-23.43%
Data (target group and population) taken and derived from the 2010 census (source above).									
Data for 2010 actual numbers of the target group and population.									
Data for target group 2025 derived from the fact that in 2025 the 16-24 years old are 15 years younger in 2010 (thus, 1-9 years old), assuming there are no changes due to migration or death.									
Data for 2010 bases birth years 1994 - 1987; data for 2025 bases on birth years 2009 - 2002.									
Source: http://www.statistik-nord.de/uploads/tx_standdocuments/A_I_3_j10.pdf									

Table 1. Target Group and Population Forecast for Schleswig-Holstein (After Statistical Office Hamburg/Schleswig-Holstein, 2010).

Schleswig-Holstein has only a few economically developed areas: Flensburg, Rendsburg, Kiel, and Lübeck, which are all medium-sized cities. Most of the state's area is devoted to agriculture. Hamburg, Germany's second largest city with a strong economy and a population of 1.8 million people, a seaport, and an airport is located just south of Schleswig-Holstein. Thus, we can consider the competition between the armed forces and civilian firms for the resource target group to be high. In this setting, the armed forces have to be set up and placed efficiently to gain a competitive advantage in the fight for this resource.

Since the branch officers primarily get in first contact with the target group, we are going to focus on them. The chief petty officers in the recruitment offices have the task of informing individual applicants in personal talks about career possibilities and guide them through the application process; however, the question about ineffective offices arises. Since Schleswig-Holstein will lose almost one-quarter of the target group population, one could assume that the

recruiting offices have too many personnel, including the chief petty officers; however, the offices will stay effective. The armed forces only employ about 25,000 new recruits each year and each recruitment office produces an average of 1,500 applicants each year (internal data). For Schleswig-Holstein, maintaining the status quo (four recruitment offices) means that they will deal with, on average, 6,000 recruits per year (resulting in 1,705 recruits in 2011; internal data). Regarding this and the fact that in 2025 the target group will number 194,874 young people, is enough to justify the same number of recruitment chief petty officers. Hence, ineffective offices are not an issue.

Therefore, the focus is on the officers getting into first contact with the target group, because this is the initial moment to get young people interested in a career in the armed forces.

A. EVALUATION OF THE STATUS QUO

As laid out above, the recruitment branch and the political education branch do not relate to each other. This becomes obvious by looking at their structure in Schleswig-Holstein. Figure 3 shows the geographical areas of responsibility of the recruitment and political information offices and their locations. Both branches maintain four offices in the state, which are, except for one, all located in different counties. The recruitment office and the political information office in Kiel, however, are located in different parts of the city.

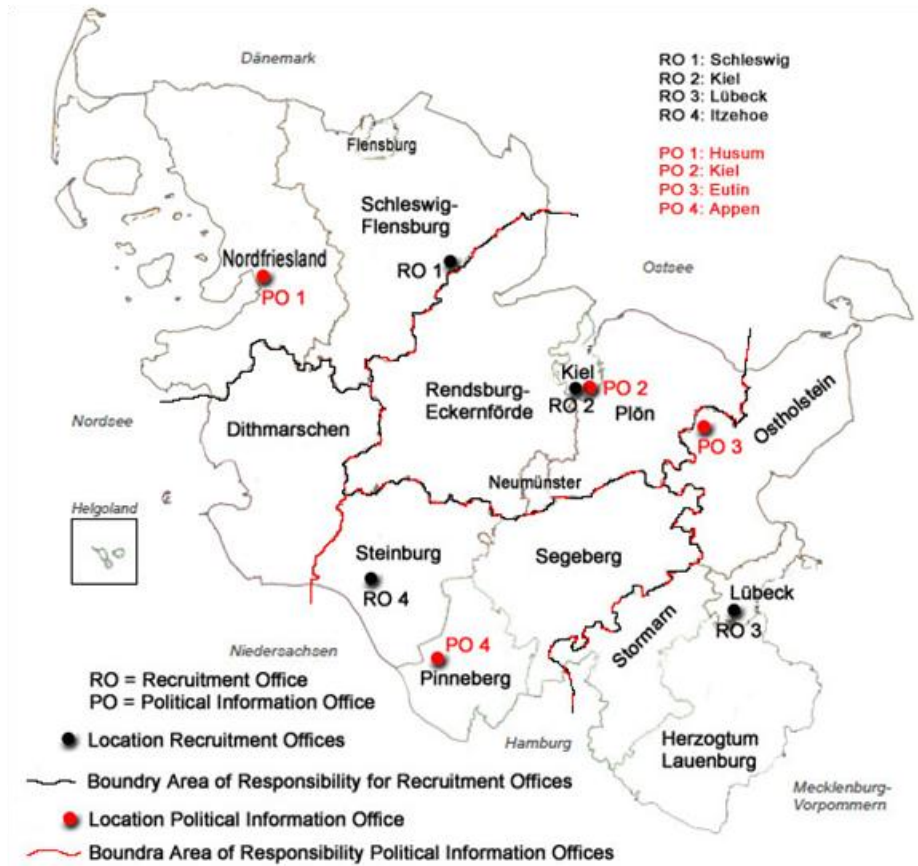


Figure 3. Areas of Responsibility of Recruitment and Political Information Offices and County Boundaries (After www.bundeswehr-karriere.de and www.jugendoffizier.eu).

In this graphic, we also see that, generally, the areas of responsibility are the same. The only difference exists in the county of Dithmarschen, where the responsibility is different. This county is assigned to the western recruiting officer, while, on the other hand, the northern political information officer is responsible.

The recruitment offices are led by an O-2 (Oberleutnant – 2nd Lieutenant), while an officer in the rank of O-3 (Kapitänleutnant/Hauptmann – 1st Lieutenant) leads the political information offices. Thus, we have four O-2s and four O-3s in the state of Schleswig-Holstein. The expenses paid for their salaries can be calculated by applying the actual salary table for soldiers, valid beginning on January 1, 2012, as seen in Table 2.

Bundesbesoldungstabelle - Besoldungsordnung A - ab 1. Januar 2012

BesGr	2 Jahres-Rhythmus		3-Jahres-Rhythmus			4-Jahres-Rhythmus		
	Stufe 1	Stufe 2	Stufe 3	Stufe 4	Stufe 5	Stufe 6	Stufe 7	Stufe 8
A 2	1744,80	1785,58	1827,44	1858,81	1891,25	1923,68	1956,09	1988,52
A 3	1814,88	1857,76	1900,65	1935,17	1969,70	2004,21	2038,73	2073,24
A 4	1854,65	1905,88	1957,14	1997,94	2038,73	2079,53	2120,32	2157,99
A 5	1869,27	1933,08	1984,33	2034,55	2084,77	2136,02	2186,22	2235,39
A 6	1911,11	1985,39	2060,70	2118,23	2177,85	2235,39	2299,20	2354,64
A 7	2010,49	2076,39	2163,23	2252,13	2338,95	2426,82	2492,72	2558,61
A 8	2131,83	2211,34	2323,26	2436,23	2549,20	2627,65	2707,15	2785,61
A 9	2307,56	2386,02	2509,46	2634,98	2758,40	2842,10	2926,83	3009,46
A 10	2475,97	2583,72	2739,58	2894,39	3049,21	3156,97	3264,69	3372,45
A 11	2842,10	3002,15	3161,13	3321,19	3431,02	3540,85	3650,69	3760,52
A 12	3047,13	3236,46	3426,83	3616,16	3747,97	3877,67	4008,43	4141,28
A 13	3573,27	3751,10	3927,89	4105,71	4228,10	4351,54	4473,91	4594,21
A 14	3674,75	3903,82	4133,96	4363,04	4520,98	4679,99	4837,94	4996,94
A 15	4491,70	4698,82	4856,77	5014,72	5172,68	5329,58	5486,49	5642,34
A 16	4955,09	5195,69	5377,70	5559,71	5740,68	5923,75	6105,74	6285,67

Table 2. Salary Table for Soldiers, Valid from January 1, 2012
(From Beamtenbesoldung, 2012).

Table 2 gives an overview of the basic salary of German soldiers according to their rank and age. It does not consider any additional payments for married soldiers or soldiers with children. Since marriage and having children are personal determinants, we will only focus on the basic salary as a comparable basis.

The rank of an O-2 compares to the salary A10 in this table, the rank of an O-3 compares to A11. The table does not name ranks like O-2 because German soldiers are paid like any other government employee (e.g., teachers) and these are the corresponding pay grades. The other steps ("Stufe" in the table) respect the living age of the soldiers. Generally, we find both ranks in "Stufe 2"; thus, the monthly salary for an O-2 is EUR 2,583.72, while for an O-3 it is EUR 3,002.15.

This results in monthly expenses on salaries for recruitment and political information officers in Schleswig Holstein of EUR 23,343.48.

Within their area of responsibility, the recruitment and political information officers travel to the cities to lecture about their special topics. Since there is a contract with a civilian car-leasing firm, we cannot reduce the cost for the used cars because they are fixed by contract. We can, calculate, however, the amount spent for commuting between the cities within the area of responsibility by multiplying the distance between the cities with the standard amount per kilometer, resulting in the following cost matrix.

ID	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1 Ahrensburg	0.00	18.48	15.12	43.68	46.20	22.26	31.08	68.04	51.66	66.78	31.92	14.70	57.96	34.86	78.12	18.48	26.04	29.40	9.66	29.82	31.08	20.58	46.20	52.08	17.64
2 Bad Schwartau		0.00	12.60	49.98	44.52	43.26	13.86	66.78	55.86	65.10	37.38	25.62	56.28	33.18	76.44	3.78	24.36	12.18	27.30	19.74	25.62	17.64	44.52	53.34	41.58
3 Bad Segeberg			0.00	38.22	32.76	30.66	15.54	55.02	44.10	53.34	26.04	13.86	44.52	21.42	64.68	13.86	12.60	18.48	17.22	16.38	17.64	24.78	32.76	41.58	26.04
4 Brunsbüttel				0.00	44.52	24.78	50.40	60.90	17.64	34.02	12.60	31.08	56.28	43.26	49.98	50.82	31.08	56.28	36.54	44.52	49.56	65.52	33.60	42.00	29.82
5 Eckernförde					0.00	55.86	30.66	26.04	28.14	23.94	31.92	36.12	11.76	11.76	35.70	47.04	23.94	36.96	44.10	24.78	19.32	62.58	10.08	10.08	51.24
6 Elmshorn						0.00	40.32	62.58	33.18	49.14	13.44	11.34	57.96	36.54	65.10	46.20	24.36	57.12	15.12	37.38	42.84	44.10	34.44	46.62	6.72
7 Eutin							0.00	55.86	50.82	54.18	40.32	28.56	42.84	19.74	65.52	16.80	21.42	6.72	31.92	6.30	12.18	30.24	33.60	42.42	40.74
8 Flensburg								0.00	37.80	19.74	49.56	53.34	19.32	38.64	14.70	69.30	41.58	63.00	61.32	50.40	44.94	79.80	27.72	18.06	68.04
9 Heide									0.00	18.06	21.00	39.06	40.32	33.18	34.02	57.96	32.34	57.12	44.94	44.94	39.06	73.92	18.06	21.84	37.80
10 Husum										0.00	37.80	50.82	27.72	36.12	15.12	66.78	39.06	60.48	58.80	48.30	42.42	77.28	25.20	15.54	53.76
11 Itzehoe											0.00	18.90	44.10	31.50	52.50	38.64	18.90	44.10	25.20	32.34	37.38	49.14	21.84	29.82	18.06
12 Kaltenkirchen												0.00	47.88	26.46	62.58	26.46	14.28	31.92	7.56	27.72	32.76	37.38	30.66	36.96	18.48
13 Kappeln													0.00	23.94	39.48	59.22	36.12	49.14	56.28	36.96	31.08	74.76	22.26	18.06	63.42
14 Kiel														0.00	47.46	35.70	14.28	26.04	34.44	13.44	7.98	52.92	15.54	21.84	42.00
15 Leck															0.00	78.12	50.40	71.82	70.56	59.64	53.76	89.04	36.54	27.30	77.70
16 Lübeck																0.00	24.78	14.70	27.30	22.26	29.82	14.28	44.94	51.24	42.00
17 Neumünster																	0.00	27.72	22.26	15.54	12.60	36.96	18.48	24.78	29.40
18 Neustadt/Hol																		0.00	38.22	12.60	18.48	28.56	39.90	46.20	52.50
19 Norderstedt																			0.00	32.34	33.60	28.56	38.22	44.10	10.92
# Plön																				0.00	5.88	35.70	27.72	34.02	42.84
21 Preetz																					0.00	40.74	22.26	28.14	47.88
# Ratzeburg																						0.00	56.28	62.16	39.90
# Rendsburg																							0.00	11.34	45.78
# Schleswig																								0.00	52.08
# Appen																									0.00

Table 3. Cost Matrix for Commuting.

We see the different cities belonging to the counties on the next page. Please notice that the cities shown in this and all other matrices in these tables represent the significant cities of Schleswig-Holstein. The numerous villages in between are left out for the simplicity of this model. We assume that the inhabitants of these villages (including the target group) are used to commuting to the nearest of the 25 cities above for going to work, attending school, or going shopping. We thus assume that leaving out these villages does not limit our model and that the target group will commute to the nearest city to apply for the armed forces. Table 4 shows in which counties the cities are located.

County	Cities in County
Nordfriesland	Husum Leck
Flensburg	Flensburg
Schleswig-Flensburg	Schleswig Kappeln
Rendsburg-Eckernförde	Eckernförde Rendsburg
Kiel	Kiel
Dithmarschen	Brunsbüttel
Steinburg	Itzehoe
Neumünster	Neumünster
Plön	Plön Preetz
Ostholstein	Eutin Neustadt/Hol
Segeberg	Bad Segeberg Bad Schwartau Kaltenkirchen
Pinneberg	Norderstedt Heide Elmshorn Appen
Lübeck	Lübeck
Stormarn	Ahrensburg
Herzogtum Lauenburg	Ratzeburg

Table 4. Cities Belonging to Counties.

In order to keep the status quo costs comparable with our model, we have to assume that each officer (recruiter and political information) visits every city within his/her area of responsibility according to the number of schools in this destination city. Table 7 gives an overview about the number of target schools in each city. If one officer has to serve Bad Schwartau, for example, he/she will travel there five times. The expenses for commuting are calculated by taking the distance between the cities (see Table 5) times the standard amount per kilometer (EUR 0.42) times the number of schools in each city (see Table 8).

In addition, we have to include the amount of money spent on rent in Lübeck and Husum (together, EUR 1,824.50).

To summarize, the recruitment branch and the political information branch in Schleswig-Holstein encounter the following costs:

Cost for Personnel per Month:	EUR 23,343.48
Cost for Office Rent per Month:	EUR 1,824.50
Costs per Month:	EUR 25,167.98
Commuting:	EUR 9,006.48
Total:	<u>EUR 34,174.46</u>

B. EVALUATION OF MERGING THE BRANCHES AND SHARING TASKS

In this analysis, we are going to use optimization modeling to find the best location for offices. As mentioned initially, the idea is to save money in the budget by merging the recruitment branch and the political information branch. The costs for the status quo were calculated in the previous section. The goal now is to find out if we can really achieve the anticipated savings. Here, we want to recall that merging the branches in the context of this section means that the officers in the newly formed branch are capable of lecturing on both recruitment and security policy issues.

To start up the optimization, we programmed a test model with only five cities in Excel to test the algebraic expressions from the next section and prove their validity. Excel, however, is not able to handle the full-sized model with all of its 650 decision variables, which is the reason why we have to program it in the General Algebraic Modeling System (GAMS). Contrary to Excel, we have to enter the algebraic formulations directly into the program (and not by referring cell contents with each other, like in Excel). The output, however, will be the same: the optimal solution.

Before programming the optimization model in Excel, we first have to set it up algebraically. Thus, we need decision variables, an objective function, and we need to identify the constraints.

1. Cost Optimization Model

a. Decision Variables

The first objective is to minimize the expenses for commuting. In order to do that, we identified the 25 major cities in Schleswig-Holstein that recruitment and political information officers frequently visit. This list also includes the current locations of the individual offices. Since we want to minimize the expenditures on commuting, rent, and personnel, the question is in which of these cities should an office of the newly formed branch be located and which cities this office should serve. Thus, the decision variables are the 25 selected cities. For simplicity, we coded them with the numbers 1 through 25, as seen in Tables 5 or 86, for example. Additionally, we use the indices i and j as city indicators. We have two different sets of decision variables, where

C_j denotes the decision if we locate an office in city j , and

$S_{i,j}$ for the city i served by an office in city j

All decision variables have to be binary, where a 1 indicates the presence of an office or a service, and a 0 otherwise.

Furthermore, we have to introduce the following sets of parameters in order to set up the objective function:

R_j denotes the rental costs for operating an office in city j ;

$D_{i,j}$ denotes the commuting costs from an office in j to city i ;

P_j denotes the personnel costs for operating a center in city j ;

$T_{i,j}$ denotes the commuting time from an office in j to city i ; and

L denotes the time limit for commuting.

b. Objective Function

First, we constructed a distance matrix (see Table 5) between each of the selected cities as well as a travel time matrix (see Table 6).

ID		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1	Ahrensburg	0	44	36	104	110	53	74	162	123	159	76	35	138	83	186	44	62	70	23	71	74	49	110	124	42
2	Bad Schwartau		0	30	119	106	103	33	159	133	155	89	61	134	79	182	9	58	29	65	47	61	42	106	127	99
3	Bad Segeberg			0	91	78	73	37	131	105	127	62	33	106	51	154	33	30	44	41	39	42	59	78	99	62
4	Brunsbüttel				0	106	59	120	145	42	81	30	74	134	103	119	121	74	134	87	106	118	156	80	100	71
5	Eckernförde					0	133	73	62	67	57	76	86	28	28	85	112	57	88	105	59	46	149	24	24	122
6	Elmshorn						0	96	149	79	117	32	27	138	87	155	110	58	136	36	89	102	105	82	111	16
7	Eutin							0	133	121	129	96	68	102	47	156	40	51	16	76	15	29	72	80	101	97
8	Flensburg								0	90	47	118	127	46	92	35	165	99	150	146	120	107	190	66	43	162
9	Heide									0	43	50	93	96	79	81	138	77	136	107	107	93	176	43	52	90
10	Husum										0	90	121	66	86	36	159	93	144	140	115	101	184	60	37	128
11	Itzehoe											0	45	105	75	125	92	45	105	60	77	89	117	52	71	43
12	Kaltenkirchen												0	114	63	149	63	34	76	18	66	78	89	73	88	44
13	Kappeln													0	57	94	141	86	117	134	88	74	178	53	43	151
14	Kiel														0	113	85	34	62	82	32	19	126	37	52	100
15	Leck															0	186	120	171	168	142	128	212	87	65	185
16	Lübeck																0	59	35	65	53	71	34	107	122	100
17	Neumünster																	0	66	53	37	30	88	44	59	70
18	Neustadt/Hol																		0	91	30	44	68	95	110	125
19	Norderstedt																			0	77	80	68	91	105	26
20	Plön																				0	14	85	66	81	102
21	Preetz				Distance between cities in kilometers																	0	97	53	67	114
22	Ratzeburg																					0	134	148	95	
23	Rendsburg																						0	27	109	
24	Schleswig																							0	124	
25	Appen																								0	

Table 5. Distances between Selected Cities. Distances are Calculated with Google Maps.

For Table 5, we used Google Maps to calculate the distance between each city (e.g., Eutin to Itzehoe, Eutin to Leck, and so on). The values are the distances from city center to city center. We are aware that the distances from the office to the schools in other cities vary, but some schools in a destination city are closer and some are farther away. The distance center to center is a good average with respect to these differences.

Second, we applied the standard cost for commuting, which is actually set at EUR 0.42 per kilometer, by multiplying the standard amount times the distance between the cities. We display the result in Table 8.

Third, we constructed a travel time matrix (see Table 6) between the cities with the help of Google Maps (as above, the displayed time is from city center to city center; however, this is most appropriate for our calculations). Here, we assumed that no officer should travel more than 60 minutes to another city. We base this limit on our experience in the German recruiting organization and on the opinion of active recruiting officers. We also have to consider, however, that the number of target schools differs in the different cities (see Table 7). Thus, we have to assume that an officer can visit only one school per day; therefore, he visits a city according to the number of target schools located there. This changes the total commuting costs that we display in total in Table 8.

ID	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
1 Ahrensburg	0	34	32	85	89	48	56	109	90	116	63	44	111	70	126	38	51	50	27	54	57	49	79	84	43	
2 Bad Schwartau		0	27	110	87	74	29	107	108	115	84	58	109	69	125	14	50	22	57	39	54	35	77	90	71	
3 Bad Segeberg			0	89	66	62	35	86	86	94	63	37	89	48	104	33	29	40	41	32	35	45	56	69	60	
4 Brunsbüttel				0	95	46	118	114	45	81	29	71	117	88	113	113	72	124	65	104	98	118	75	91	57	
5 Eckernförde					0	87	62	51	66	58	70	63	26	27	69	94	47	79	78	49	40	108	26	26	83	
6 Elmshorn						0	94	105	53	88	26	32	108	69	120	79	52	90	29	84	79	82	72	80	19	
7 Eutin							0	94	99	102	92	69	85	44	112	36	48	21	73	15	29	55	64	77	92	
8 Flensburg								0	81	47	89	82	47	62	36	115	66	112	97	81	72	127	45	34	101	
9 Heide									0	45	37	77	89	65	77	116	67	114	72	84	75	125	43	56	62	
10 Husum										0	70	90	66	69	41	123	73	119	104	89	80	135	53	41	96	
11 Itzehoe											0	46	92	63	101	87	47	99	45	79	73	99	50	66	35	
12 Kaltenkirchen												0	83	43	97	62	27	74	27	58	53	74	49	55	35	
13 Kappeln													0	51	76	118	70	102	101	72	63	131	49	42	105	
14 Kiel														0	77	76	28	60	59	30	21	90	30	35	65	
15 Leck															0	132	83	129	114	98	89	144	62	50	119	
16 Lübeck																0	54	30	61	48	60	34	81	86	75	
17 Neumünster																	0	63	42	33	34	68	35	40	49	
18 Neustadt/Hol																		0	73	32	46	51	81	86	87	
19 Norderstedt				Distance between cities in minutes																0	65	69	76	65	71	26
20 Plön																				0	16	65	51	56	81	
21 Preetz																					0	77	42	47	76	
22 Ratzeburg																						0	94	100	79	
23 Rendsburg																							0	21	71	
24 Schleswig																								0	77	
25 Appen																									0	

Table 6. Travel Time between Cities. Times Calculated with Google Maps.

ID		Lower Schools	Middle Schools	High Schools	Integrated Schools	Total
1	Ahrensburg	1	1	2	2	6
2	Bad Schwartau			3	2	5
3	Bad Segeberg			2	3	5
4	Brunsbüttel		1	1		2
5	Eckernförde		1	1	3	5
6	Elmshorn		1	2	4	7
7	Eutin			2	2	4
8	Flensburg	1	1	4	4	10
9	Heide	1	1	2	1	5
10	Husum			2	3	5
11	Itzehoe		1	3	4	8
12	Kaltenkirchen		1	1	1	3
13	Kappeln	1		1	1	3
14	Kiel		7	11	12	30
15	Leck				1	1
16	Lübeck	4	4	7	17	32
17	Neumünster	1	3	4	7	15
18	Neustadt/Hol			1	1	2
19	Norderstedt		2	4	4	10
20	Plön		1	1	1	3
21	Preetz	1	1	1	1	4
22	Ratzeburg			1	1	2
23	Rendsburg		1	3	3	7
24	Schleswig	2		2	4	8
25	Appen					0
	Average					7
Source: http://schulportraits.schleswig-holstein.de/portal/schule_suchen/						

Table 7. School Distribution in Each City (After Schulportaets, 2012).

ID		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1	Ahrensburg	0.00	92.40	75.60	87.36	231.00	155.82	124.32	680.40	258.30	333.90	255.36	44.10	173.88	1,045.80	78.12	591.36	390.60	58.80	96.60	89.46	124.32	41.16	323.40	416.64	0.00
2	Bad Schwartau	110.88	0.00	25.20	99.96	222.60	302.82	55.44	667.80	279.30	325.50	299.04	76.86	168.84	995.40	76.44	120.96	365.40	24.36	273.00	59.22	102.48	35.28	311.64	426.72	0.00
3	Bad Segeberg	90.72	63.00	0.00	76.44	163.80	214.62	62.16	550.20	220.50	266.70	208.32	41.58	133.56	642.60	64.68	443.52	189.00	36.96	172.20	49.14	70.56	49.56	229.32	332.64	0.00
4	Brunsbüttel	262.08	249.90	191.10	0.00	222.60	173.46	201.60	609.00	88.20	170.10	100.80	93.24	168.84	1,297.80	49.98	1,626.24	466.20	112.56	365.40	133.56	198.24	131.04	235.20	336.00	0.00
5	Eckernförde	277.20	222.60	163.80	89.04	0.00	391.02	122.64	280.40	140.70	119.70	255.36	108.36	35.28	352.80	35.70	1,505.28	359.10	73.92	441.00	74.34	77.28	125.16	70.56	80.64	0.00
6	Elmshorn	133.56	216.30	153.30	49.56	279.30	0.00	161.28	625.80	165.90	245.70	107.52	34.02	173.88	1,096.20	65.10	1,478.40	365.40	114.24	151.20	112.14	171.36	88.20	241.08	372.96	0.00
7	Eutin	186.48	69.30	77.70	100.80	153.30	282.24	0.00	558.60	254.10	270.90	322.56	85.68	128.52	592.20	65.52	537.60	321.30	13.44	319.20	18.90	48.72	60.48	235.20	339.36	0.00
8	Flensburg	408.24	333.90	275.10	121.80	130.20	438.06	223.44	0.00	189.00	98.70	396.48	160.02	57.96	1,159.20	14.70	2,217.60	623.70	126.00	613.20	151.20	179.76	159.60	194.04	144.48	0.00
9	Heide	309.96	279.30	220.50	35.28	140.70	232.26	203.28	378.00	0.00	90.30	168.00	117.18	120.96	995.40	34.02	1,854.72	485.10	114.24	449.40	134.82	156.24	147.84	126.42	174.72	0.00
10	Husum	400.68	325.50	266.70	68.04	119.70	343.98	216.72	197.40	90.30	0.00	302.40	152.46	83.16	1,083.60	15.12	2,136.96	585.90	120.96	588.00	144.90	169.68	154.56	176.40	124.32	0.00
11	Itzehoe	191.52	186.90	130.20	25.20	159.60	94.08	161.28	495.60	105.00	189.00	0.00	56.70	132.30	945.00	52.50	1,236.48	283.50	88.20	252.00	97.02	149.52	98.28	152.88	238.56	0.00
12	Kaltenkirchen	88.20	128.10	69.30	62.16	180.60	79.38	114.24	533.40	195.30	254.10	151.20	0.00	143.84	793.80	62.58	846.72	214.20	63.84	75.60	83.16	131.04	74.76	214.62	295.68	0.00
13	Kappeln	347.76	281.40	222.60	112.56	58.80	405.72	171.36	193.20	201.60	138.60	352.80	143.64	0.00	718.20	39.48	1,895.04	541.80	98.28	562.80	110.88	124.32	149.52	155.82	144.48	0.00
14	Kiel	209.16	165.90	107.10	86.52	58.80	255.78	78.96	386.40	165.90	180.60	252.00	79.38	71.82	0.00	47.46	1,142.40	214.20	52.08	344.40	40.32	31.92	105.84	108.78	174.72	0.00
15	Leck	468.72	382.20	323.40	99.96	178.50	455.70	262.08	147.00	170.10	75.60	420.00	187.74	118.44	1,423.80	0.00	2,499.84	756.00	143.64	705.60	178.92	215.04	178.08	255.78	218.40	0.00
16	Lübeck	110.88	18.90	69.30	101.64	235.20	323.40	67.20	693.00	289.80	333.90	309.12	79.38	177.66	1,071.00	78.12	0.00	371.70	29.40	273.00	66.78	119.28	28.56	314.58	409.92	0.00
17	Neumünster	156.24	121.80	63.00	62.16	119.70	170.52	85.68	415.80	161.70	195.30	151.20	42.84	108.36	428.40	50.40	792.96	0.00	55.44	222.60	46.62	50.40	73.92	129.36	198.24	0.00
18	Neustadt/Hol	176.40	60.90	92.40	112.56	184.80	399.84	26.88	630.00	285.60	302.40	352.80	95.76	147.42	781.20	71.82	470.40	415.80	0.00	382.20	37.80	73.92	57.12	279.30	369.60	0.00
19	Norderstedt	57.96	136.50	86.10	73.08	220.50	105.84	127.68	613.20	224.70	294.00	201.60	22.68	168.84	1,033.20	70.56	873.60	333.90	76.44	0.00	97.02	134.40	57.12	267.54	352.80	0.00
20	Plön	178.92	98.70	81.90	89.04	123.90	261.66	25.20	504.00	224.70	241.50	258.72	83.16	110.88	403.20	59.64	712.32	233.10	25.20	323.40	0.00	23.52	71.40	194.04	272.16	0.00
21	Preetz	186.48	128.10	88.20	99.12	96.60	299.88	48.72	449.40	195.30	212.10	299.04	98.28	93.24	239.40	53.76	954.24	189.00	36.96	336.00	17.64	0.00	81.48	155.82	225.12	0.00
22	Ratzeburg	123.48	88.20	123.90	131.04	312.90	308.70	120.96	798.00	369.60	386.40	393.12	112.14	224.28	1,587.60	89.04	456.96	554.40	57.12	285.60	107.10	162.96	0.00	393.96	497.28	0.00
23	Rendsburg	277.20	222.60	163.80	67.20	50.40	241.08	134.40	277.20	90.30	126.00	174.72	91.98	66.78	466.20	36.54	1,438.08	277.20	79.80	382.20	83.16	89.04	112.56	0.00	90.72	0.00
24	Schleswig	312.48	266.70	207.90	84.00	50.40	326.34	169.68	180.60	109.20	77.70	238.56	110.88	54.18	655.20	27.30	1,639.68	371.70	92.40	441.00	102.06	112.56	124.32	79.38	0.00	0.00
25	Appen	105.84	207.90	130.20	59.64	256.20	47.04	162.96	680.40	189.00	268.80	144.48	55.44	190.26	1,260.00	77.70	1,344.00	441.00	105.00	109.20	128.52	191.52	79.80	320.46	416.64	0.00

Table 8. Commuting Expenses according to the Number of Schools.

The assumption that each officer visits each city in accordance with the number of target schools in it is also part of the constraints. Referring to Table 6, we can find out all cities located within 60 minutes' travel time of any selected city. By referring to Table 8, we can also calculate the expenditures for commuting under the above-described assumption.

For example, for the first city, Ahrensburg (C_1), cities within this radius would be Bad Schwartau ($D_{2,1}$), Bad Segeberg ($D_{3,1}$), Elmshorn ($D_{6,1}$), Eutin ($D_{7,1}$), Kaltenkirchen ($D_{12,1}$), Lübeck ($D_{16,1}$), Neumünster ($D_{17,1}$), Neustadt ($D_{18,1}$), Norderstedt ($D_{19,1}$), Plön ($D_{20,1}$), Preetz ($D_{21,1}$), Ratzeburg ($D_{22,1}$), and Appen ($D_{25,1}$). The cost for commuting would then be EUR 1,884.54.¹ This cost only shows up, however, if we choose to open an office within the constrained distance. The same logic applies to all other cities accordingly.

The second part of the objective function is the rental costs. As calculated earlier, the rental costs are EUR 912.25 for every city R_j , where no military installation is present that we can use to open an office and if we choose to open an office in city R_j . For cities with a military installation, the rental cost R_j is zero.

The third part of the objective function conveys the personnel costs. If we choose to open an office in city P_j , we need to staff it with one recruiting officer (earning EUR 3,002.15, referring to Table 4) and two recruiting chief petty officers (each one earning EUR 2,211.34, referring to Table 2), resulting in overall monthly personnel costs of EUR 7,724.83. This number of personnel is

¹ Traveling five times to Bad Schwartau (= EUR 92.40), five times to Bad Segeberg (= EUR 75.60), seven times to Elmshorn (= EUR 155.82), four times to Eutin (= EUR 124.32), three times to Kaltenkirchen (= EUR 44.10), 32 times to Lübeck (= EUR 591.36), 15 times to Neumünster (= EUR 390.60), two times to Neustadt (= EUR 58.80), 10 times to Norderstedt (= EUR 96.60), three times to Plön (= EUR 89.46), four times to Preetz (= EUR 124.32), two times to Ratzeburg (= EUR 41.16) and zero times to Appen produces this total cost. Note that Table 8 is already adjusted and represents the total cost of commuting according to the number of schools (a combination of Tables 5 and 7). The value for travelling from Ahrensburg to Bad Schwartau, for example, is calculated by the distance between the cities times the number of schools in Bad Schwartau times the standard amount (EUR 0.42) per kilometer: $44 * 5 * 0.42 = 92.40$.

enough to serve all schools of interest within the area of responsibility and all expected visitors to the office.

Since we want to minimize costs, the objective function as stated earlier would then be:

Minimize Commuting Costs + Rental Costs + Personnel Costs

$$\sum_{i=1}^{25} \sum_{j=1}^{25} D_{i,j} S_{i,j} + \sum_{j=1}^{25} R_j C_j + \sum_{j=1}^{25} P_j C_j . \quad (1a)$$

By minimizing this function we expect to find the optimal solution; thus, the location of offices from which the expenses for commuting are the lowest.

c. Constraints

First, we have to ensure that we serve a city only if an office exists in C_j , that is able to serve the city i . The corresponding algebraic constraint is

$$\sum_{i=1}^{25} S_{i,j} \leq M C_j \quad \forall j = 1 \text{ to } 25, \quad (1b)$$

where M is a very large number that does not constrain any further.

The possible locations of offices in Schleswig-Holstein might result in two or more offices being able to serve the same city, depending on the commuting time constraint below. We want to ensure, however, that only one office is responsible for every city to avoid this “double serving.” Thus, the according algebraic constraint is

$$\sum_{j=1}^{25} S_{i,j} = 1 \quad \forall i = 1 \text{ to } 25. \quad (1c)$$

Third, we want to ensure that we do not exceed a certain commuting time to drive from one city to another (one-way). Regarding our experience, as well as statements from several recruiting officers, we set this limit L at 60 minutes of driving. This time pays respect to the fact that schools in Germany start at 8:00 a.m. and we have to allow enough time (including possible

traffic congestion) for the recruiting officer to arrive at his/her destination. This limit also accounts for the fact that the recruiting officer might have to visit his/her office before leaving. Work time starts either with entering the office or, if the recruiting officer starts to the destination city from home, with leaving for the destination city. Thus, the corresponding algebraic formulation of this constraint is:

$$T_{i,j}S_{i,j} \leq L \quad \forall i = 1 \text{ to } 25, j = 1 \text{ to } 25, \quad (1d)$$

where L is set at 60.

Finally, we have to ensure that the decision variables are all binary. Since these variables *are* all binary, we do not need to account for nonnegativity.

$$C_i \in \{0,1\} \quad \forall i \quad (1e)$$

$$S_{i,j} \in \{0,1\} \quad \forall i, j. \quad (1f)$$

d. Results

After solving the completed model, we see that the constraints are optimally satisfied and we find a feasible solution to the problem. We see that only one office is assigned to each city (and no city is served by two or more offices), which means that each city is within 60 minutes' driving distance of one office. We also observe that the county borders do not limit the optimization output.

After optimization, we see that the suggested cities for an office location are the cities coded 7, 24, and 25 (Eutin, Schleswig, and Appen), generating a total cost of EUR 25,114.53. We show their assignment to the other cities in Table 9.

ID		Eutin	Schleswig	Appen
1	Ahrensburg			X
2	Bad Schwartau	X		
3	Bad Segeberg	X		
4	Brunsbüttel			X
5	Eckernförde		X	
6	Elmshorn			X
7	Eutin	X		
8	Flensburg		X	
9	Heide		X	
10	Husum		X	
11	Itzehoe			X
12	Kaltenkirchen			X
13	Kappeln		X	
14	Kiel	X		
15	Leck		X	
16	Lübeck	X		
17	Neumünster	X		
18	Neustadt/Hol	X		
19	Norderstedt			X
20	Plön	X		
21	Preetz	X		
22	Ratzeburg	X		
23	Rendsburg		X	
24	Schleswig		X	
25	Appen			X

Table 9. Optimization Output When an Officer Can Hold Both Lectures.

We interpret the result in the following way. First, we see that, compared to the status quo, the offices are reduced from eight to only three; thus, by 62.5%. These three offices are staffed with one recruiting officer and two recruiting petty officers. Compared to the total costs of the status quo (EUR 34,174.46), after optimization we encounter total costs of only EUR 25,114.53 (a reduction of 26.51%).

In the above-described scenario, we now have to consider moving costs that appear one time when relocating the offices. From the eight offices in the actual setting, we reduce to three offices. All chosen locations for offices are in cities that already host an office in the status quo. Thus, the other five offices have to move. We can assume moving costs of EUR 5,000 (due to the sheer volume of furniture, personnel costs, etc., based on estimates from moving

companies); thus, a total of EUR 25,000 that appears once when changing the structure. We recover those expenses due to the savings we make when we merge the branches. Under this alternative, we save EUR 9,059.93 monthly. Thus, the moving expenses would be amortized after three months (EUR 25,000/EUR 9,059.93).

If we assume a life cycle of the new structure until 2025 (the end of the population forecast of the 2010 census from the statistical office) we could make the following calculation: if the new structure had become effective in January 2013, the moving costs would be recovered by April 2013. Until the end of 2025, this would mean a savings of EUR 2,473,360.89 (273 months times EUR 9,059.93).

2. Additional Considerations

a. Increasing the Number of Lectures

The next question is how to increase the number of lectures that the new branch officers are having in front of the target group. In 2010, political information officers informed the target group on 7,350 events countrywide (Schnittker, 2011). Since we have 94 political information officers in Germany, we can calculate an average of 78 events per officer per year. Besides the lectures, this number also contains the game Pol&IS, an interactive game that is played with classes and simulates political and economic correlations in the world. The preparation of this game is very time-consuming (approximately four days for the game, plus one day of preparation) and leads to a lower output in the number of lectures.

Contrary to the political information officers, recruiting officers have on average 150 lectures per year (internal data). When one officer is able to lecture about recruiting and political information topics, we expect the number of recruiting lectures to decrease because one of the duties is also preparing and executing the above-described game. We can assume that each officer in the new structure will hold, on average, 114 lectures $((78+150)/2)$. In the new branch,

however, all officers in Schleswig-Holstein will have, on average, 342 lectures, which is less than in the status quo (912 lectures). We will lose 570 lectures because we reduce the number of branch officers from eight to three and, thus, have to take into account the loss in output. Staffing the offices with more officers that can lecture on both topics is an option that we analyze in the sensitivity analysis later in this chapter.

A way to work against this loss in output is to look at the contents of the lecture itself. Both security policy lectures and recruiting lectures are designed to last 90 minutes, the equivalent of two school hours (45 minutes each) in Germany. The contents of the security policy lectures are very dense and there is no room to skip a topic. The recruitment lectures, on the other hand, contain all the information from the very beginning of the recruiting process (e.g., how to apply, what is tested, different career opportunities) to the very end of the commitment period (e.g., which payments are made after how much time in the armed forces, further educational opportunities). This last part of these lectures takes approximately 15 minutes to explain. Now recall that the officers are talking to young men and women aged 16+. These pupils usually do not think 8–13 years ahead (the commitment time); they are interested in obtaining a good job, with good pay, and vocational training (which is what the German armed forces offers). Also, note that the last part of these lectures appears again in the personal talks with a recruiter (where career opportunities are assessed for the individual) and they reappear again during basic military training. Thus, we can think about cutting this part out of the general recruiting lecture and save 15 minutes. By doing so, we gain room for one additional lecture every five lectures (+20%). If an officer is in the fortunate position to be able to hold more lectures in the same school, this could increase his/her output.

Now we have to try to put a monetary value on these lectures in order to find out how much we gain by shortening the lectures. As already laid out above, all officers working in the new branch are in the rank of O-3 and earn a basic salary of EUR 3002.15. If we now consider 20 work days per month and

eight work hours per day, we can calculate an hourly wage of EUR 18.76. This result, multiplied by 1.5, returns a wage of EUR 28.15 for 90 minutes. Hence, we can assume that a lecture has a value of EUR 28.15 (in fact, these are the personnel costs, but since we cannot apply a monetary value to the lecture, these personnel costs serve as an instrument). By taking out the last part of the recruitment lecture, we reduce this value to EUR 23.45. Since we can hold one more recruiting lecture every five lectures, however, we gain EUR 23.45 every five lectures. We are aware that the officers receive the same salary every month, regardless of the number of lectures they hold. If we see the salary of an officer as investment, we can increase the return on this investment by EUR 23.45.

It does not seem reasonable, however, to shorten the lectures to gain 15 minutes. Let us assume that the officer has another lecture directly after finishing the first one in the same school. If we shortened the lecture now, the officer would be finished lecturing 15 minutes before the school hour is over. But, he cannot go straight to the next class, because the pupils there are still sitting in their normal lesson and will not be finished 15 minutes earlier to meet the officer's lecture time.

b. Increasing the Number of Visitors

Furthermore, we can try to increase the number of visitors to the offices. Here, we focus on recruitment issues because political information does not involve public traffic to offices. In addition, we have to focus on the recruitment chief petty officers because they are the ones that deal with the visitors in the offices (the officers usually lecture at schools and make the first contact). When an interested person enters a recruitment office, he or she has a personal talk with one of the recruiters in the office, which lasts 60 minutes, on average. This talk contains detailed information about the application process, individual career opportunities (based on the applicant's school grades and other qualifications), and ends in a job and education offer for the applicant that is

binding for the armed forces. This personal talk also contains information about the end of the commitment time (e.g., which payments are made after how much time in the armed forces, further educational opportunities). This part takes, on average, 10 minutes and is part of the 60-minute total. Please recall that this information is also part of the basic military training in the first days of the recruit's service. A workday lasts eight hours. Thus, a recruiter could have, at most, eight talks per day. If we cut out this part (and substitute it by an information paper), we could gain 10 minutes per talk and one personal talk every six talks. Thus, we were able to raise the maximum number of talks that a recruiter can have per day from eight to nine.

As we did with the recruitment lectures above, we are now going to add a monetary value to the individual talks. A recruiter earns, on average, EUR 2,436.23 per month (compare to Table 2, A8, step 4). Assuming, on average, 20 workdays per month and 8 work hours per day, we calculate an hourly wage of EUR 15.22. Thus, the cost of a one-hour individual talk is EUR 15.22. If we cut out the last part of the talk, we would reduce the duration down to 50 minutes and the cost of this individual talk would decrease to EUR 12.69. Now, the maximum number of talks that a recruiter can have on any given day is raised from eight to nine. Thus, we gain EUR 12.68 per day and recruiter. For the six recruiters in the new structure in Schleswig-Holstein this would mean a gain of EUR 1,522.80 per month. Bottom line, by reducing the duration of the personal talks we can raise the number of visitors to any office by 20 per recruiter and month (one additional talk per day for 20 workdays) and increase the return on investment (the salaries) by EUR 507.20 per office (two recruiters * EUR 12.68 * 20 workdays).

3. Merging the Branches, Sharing Tasks: Summary

After solving with our model, the optimal solution suggests opening branch offices in Eutin (7), Schleswig (24), and Appen (25). Each office will be staffed with one officer who is able to lecture on both topics and two recruiters. The total

expenditures (salaries, rent, commuting) are EUR 25,114.53. This means a reduction in expenditures of 26.51% compared to the status quo costs.

The expenditures that arise from closing offices and moving the furniture are amortized after three months (considering the above-mentioned savings).

Trying to raise the number of lectures turns out to be ineffective. Since the duration of the school hours does not change, increasing the number of possible lectures by deleting a part of the contents only results in idle time for the officers.

On the other hand, we can increase the number of visitors to the offices by shortening the recruiting talks. Taking a 10-minute portion out of these talks (which is discussed later) increases the possible number of visitors per recruiter per day from eight to nine. This would increase the return on investment (salaries) by EUR 507.20 per office and month. Thus, we should opt to shorten the talks because it increases effectiveness. We can assume that the shortened lecture is as effective as the original one because we still cover all requirements and opportunities of a military career.

As a final overview, we encounter the following expenditures for this alternative:

Cost for Personnel per Month:	EUR 7,424.83
Cost for Office Rent per Month:	EUR 912.25
Costs per Month:	EUR 8,337.08
Commuting:	EUR 16,777.45
Total:	<u>EUR 25,114.53</u>

C. EVALUATION OF MERGING THE BRANCHES AND DIVIDED TASKS

1. Cost Optimization Model

The commuting cost optimization model for merging the branches, but keeping the branches separate within, is generally the same model as in Section B. The difference, however, is we now need two officers in every office

for the specific topic and each of them has to visit every city within the area of responsibility (AOR). We apply the same constraints as already seen in the previous section. Table 10 shows the office locations and their assignment to the other cities after optimization.

ID		Bad Schwartau	Itzehoe	Schleswig
1	Ahrensburg	X		
2	Bad Schwartau	X		
3	Bad Segeberg	X		
4	Brunsbüttel		X	
5	Eckernförde			X
6	Elmshorn		X	
7	Eutin	X		
8	Flensburg			X
9	Heide		X	
10	Husum			X
11	Itzehoe		X	
12	Kaltenkirchen		X	
13	Kappeln			X
14	Kiel			X
15	Leck			X
16	Lübeck	X		
17	Neumünster		X	
18	Neustadt/Hol	X		
19	Norderstedt		X	
20	Plön	X		
21	Preetz			X
22	Ratzeburg	X		
23	Rendsburg			X
24	Schleswig			X
25	Appen		X	

Table 10. Optimization Output When We Have One Officer for Each Lecture.

We see that the suggested cities for office locations are the cities coded 2, 11, and 24 (Bad Schwartau, Itzehoe, and Schleswig), generating a total cost of EUR 36,940.03. These costs include the expenditures for salaries (different salaries for officers and chief petty officers), rent, and commuting.

We interpret the result in the following way. First, we see that, compared to the status quo, the offices are reduced from eight to only three; thus, by

62.5%. We staff these offices with two (!) recruiting officers and two recruiting chief petty officers. Reducing the number of officers from eight to six saves money; however, commuting expenses rise significantly so that, compared to the total costs of the status quo (EUR 34,174.46), we encounter total costs of EUR 36,940.03 (an increase of 8.09%) after optimization.

In the above-described scenario, we now have to consider one-time moving costs when relocating the offices. From the eight offices in the actual setting, we reduce down to three offices. Two chosen locations for offices are in cities that already host an office in the status quo. Thus, the other six offices have to move. We can assume moving costs of EUR 5,000 (due to the sheer volume of furniture, personnel costs, etc.; estimates from moving companies); thus, a total of EUR 30,000 that appears once when changing the structure. Since the total costs are above those of the status quo, we cannot recover these moving costs. Assuming that we would have started this new structure in January 2013, we would have a total loss of EUR 431,428.92 (156 months * EUR -2,765.57).

2. Additional Considerations

a. Increasing the Number of Lectures

The next question is how to increase the number of lectures that the new branch officers are having in front of the target group. Our considerations here are the same as in the evaluation of merging the branches with combined tasks for the officers. For the detailed considerations, refer to Section IV.B.2.a.

b. Increasing the Number of Visitors

Furthermore, we can try to increase the number of visitors to the offices. Our considerations here are the same as in the evaluation of merging the branches with combined tasks for the officers. For the detailed considerations, refer to Section IV.B.2.b.

3. Merging the Branches, Divided Tasks: Summary

After solving with our model, the optimal solution suggests to open branch offices in Bad Schwartau (2), Itzehoe (11), and Schleswig (24). Each office will be staffed with two officers who lecture on their specific topics and two recruiters. The total expenditures (salaries, rent, and commuting) are EUR 36,940.03. This means an increase in expenditures of 8.09% compared to the status quo costs. The expenditures that arise from closing offices and moving the furniture cannot be recovered and this alternative will cost the armed forces considerably more money over the life cycle (EUR 431,428.92).

Trying to raise the number of lectures turns out to be ineffective. The lectures are designed to last 90 minutes, the equivalent of two school hours. Increasing the number of possible lectures by deleting a part of the contents results in idle time for the officers because the duration of the school hours does not change.

On the other hand, we can increase the number of visitors to the offices by shortening the recruiting talks. Taking a 10-minute portion out of these talks (which is discussed later) increases the possible number of visitors per recruiter per day from eight to nine. This would increase the return on investment (salaries) by EUR 507.20 per office and month. Thus, we should opt to shorten the talks because it increases effectiveness.

As a final overview, we encounter the following expenditures for this alternative:

Cost for Personnel per Month:	EUR 10,426,98
Cost for Office Rent per Month:	EUR 912.25
Costs per Month:	EUR 11,339.23
Commuting:	EUR 25,600.80
Total:	<u>EUR 36,940.03</u>

D. COMPARING THE ALTERNATIVES

In this section, we are going to compare the three alternatives: maintaining the status quo, merging the branches with equal tasks within the branch, and merging the branches with divided tasks within the branch. This comparison will be in the form of a cost-effectiveness matrix, in which we can place and evaluate the alternatives with respect to their costs and corresponding effectiveness.

Before we can set up the cost-effectiveness matrix, we have to translate the measures of Section III.A.6.b into a [0; 1] scale to make them comparable with each other. Recall from Section 3.A.7 (Criteria Valuing) that we have to find measures that are “good enough” or “not enough” for this criterion. If the values we found in the section above meet or exceed the “good enough” measure, we are going to assign the factor 1 to them. Accordingly, we are going to assign the factor 0, if the values lie below the measure for “not enough.” For all values in between those two measures, we apply the following formula to find the corresponding factor:

$$\frac{Measure - not.enough}{good.enough - not.enough} .$$

The boundaries for “maximize lectures” were 560 (not enough) and 1,200 (good enough). As shown in Sections B and C, the average number of lectures for merging the branches with equal tasks is 342 lectures and, for divided tasks within the branch, we find an average of 684 lectures, while the status quo is able to support, on average, 912 lectures. Figure 4 provides an overview of the results we calculated earlier.

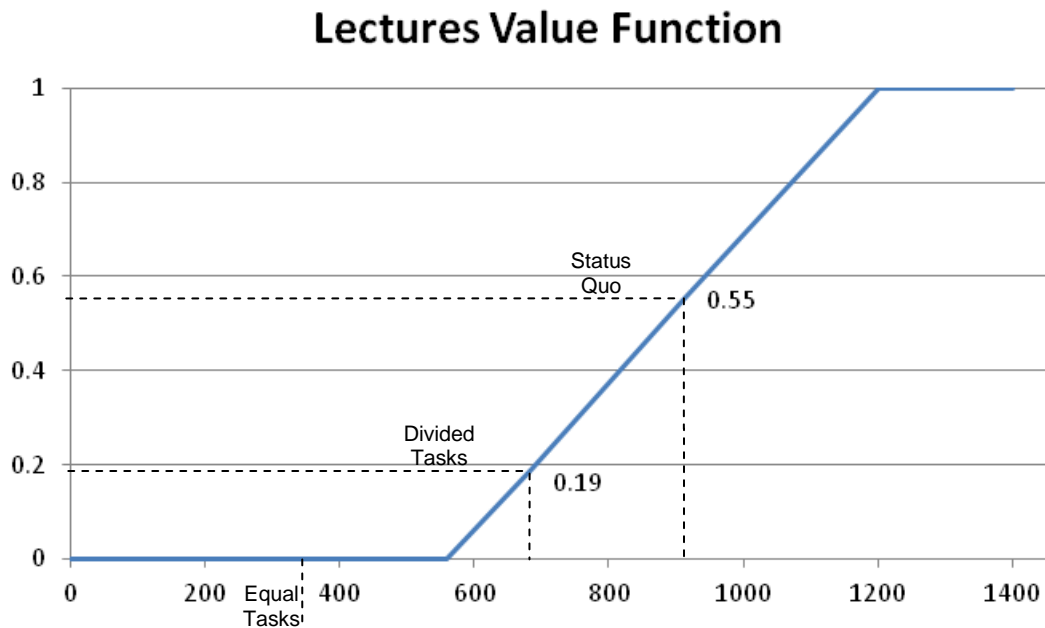


Figure 4. Lectures Value Function.

The x-axis of this function displays the number of lectures and the y-axis displays the corresponding value of the attribute. We can see that we calculated the value 0.55 for 912 lectures in the status quo by using the function above. Accordingly, we calculated 0.19 for merging the branches where we have specialized topics for the officers, and we find a value of 0 for merging the branches where one officer is able to talk about both topics. Please note that the total of 912 lectures was obtained by eight officers, while only six officers contributed to the result of 684 lectures (two officers were assigned to other duties), and three officers are able to obtain a result of only 342 lectures (five officers were assigned to other duties). Now we have to multiply the results above with the factor 0.5 to account for their weighting and we obtain the following values:

Status quo:	0.275
Merging with equal tasks:	0.000
Merging with divided tasks:	0.095

In the same manner, we evaluate the visitors to the offices. For the status quo, we calculate the value of 0.67, and for merging the branches (no matter whether the tasks are divided or not) we calculate the value of 1 (see Figure 5).

The x-axis in Figure 5 displays the number of lectures and the y-axis displays the corresponding value of the attribute. We can see that merging the branches raises the number of recruiting talks in the offices. As above, we have to multiply the values by 0.5 to account for their weighting. The results are:

Status quo:	0.335
Merging with equal tasks:	0.500
Merging with divided tasks:	0.500

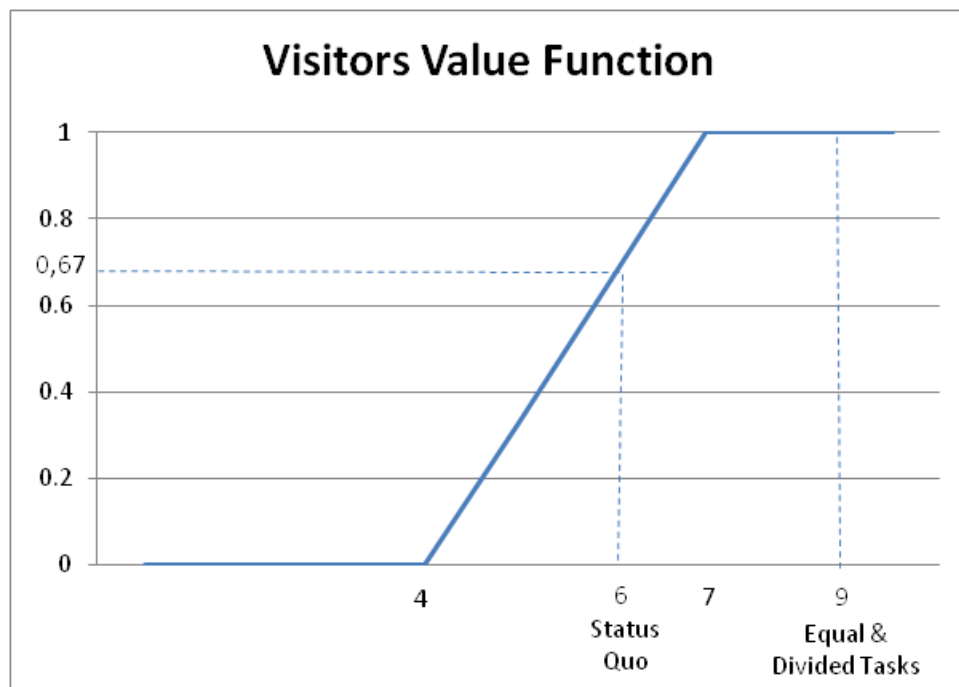


Figure 5. Visitors Value Function.

As a final step, we now have to add the values for the attributes of the alternatives together to obtain the total value of effectiveness for each alternative.

Status quo: $0.275 + 0.335 = \mathbf{0.610}$

Merging with equal tasks: $0.000 + 0.5 = \mathbf{0.500}$

Merging with divided tasks: $0.095 + 0.5 = \mathbf{0.595}$

As a final step, we now have to take the calculated expenditures from the optimization model into account. Those expenditures were for:

Status quo: EUR 34,174.46

Merging with equal tasks: EUR 25,114.53

Merging with divided tasks: EUR 36,940.03

With this information, we can construct a cost-effectiveness matrix and locate the three alternatives with respect to their anticipated costs and their effectiveness.

Comparing cost and effectiveness, we obtain the picture shown in Figure 6. On the x-axis, we see the calculated expenditures for each alternative. The y-axis displays the effectiveness.

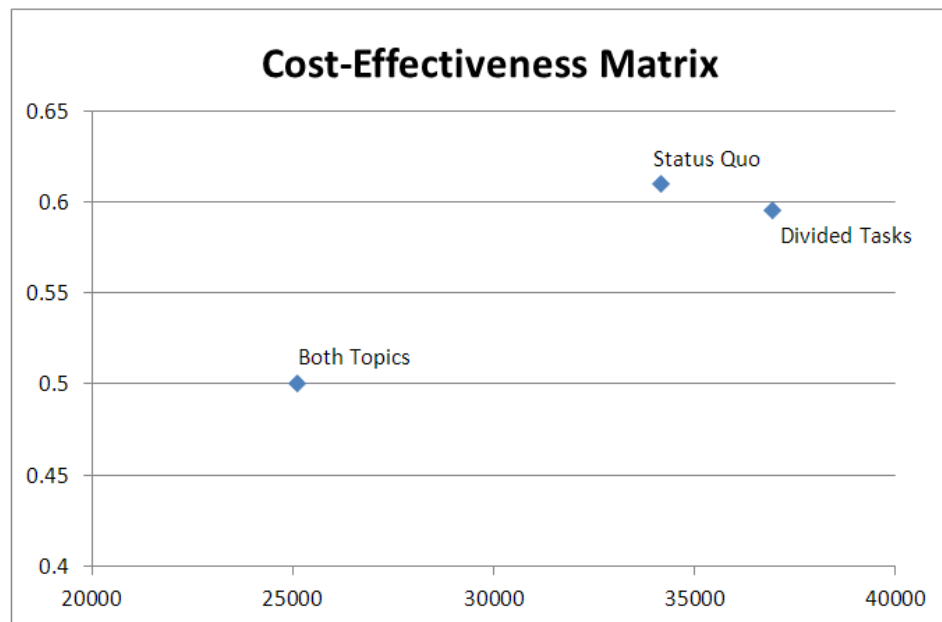


Figure 6. Cost-effectiveness Matrix.

We can clearly see that merging the recruitment branch and political information branch, and letting the officers in the newly formed branch lecture on recruitment and security policy issues, leads to a solution that is significantly cheaper, but also the least effective.

When choosing this solution, we expect expenditures of EUR 25,114.53. Compared to the status quo (EUR 34,174.46), we could save EUR 9,059.93 (26.51%) of the current expenses. This, however, is a trade-off because we are also losing some effectiveness.

Merging the branches and keeping the lecture topics specific appears to be no possible solution, since this alternative is more expensive (plus EUR 2,765.57) than the status quo and less effective.

E. SENSITIVITY ANALYSIS

After the results we found above, the question arises of what is going to happen to the outcomes if one of the assumptions changes. Specifically, we pose the question of how the outcomes are affected when we change the commuting times or the number of officers in the offices.

1. Commuting Times

Regarding the commuting times first, we wanted to evaluate what would happen if we constrained the allowed time for commuting (one-way) to 30 minutes and what would happen if we allowed 90 minutes for commuting. Thus, we repeated the analysis, assuming, first, that no officer should commute longer than 30 minutes one-way to any city within his/her area of responsibility and, second, we assume that no officer should drive more than 90 minutes to any location.

As expected, reducing the commuting times to only 30 minutes raises the number of needed offices significantly. We display the results in Table 11. The columns show the identifier (ID) for the city hosting an office, while the crosses in the same column indicate which cities belong to the area of responsibility of this office.

ID		2	5	8	9	10	11	14	15	19	22
1	Ahrensburg									X	
2	Bad Schwartau	X									
3	Bad Segeberg	X									
4	Brunsbüttel					X					
5	Eckernförde		X								
6	Elmshorn					X					
7	Eutin	X									
8	Flensburg			X							
9	Heide				X						
10	Husum					X					
11	Itzehoe						X				
12	Kaltenkirchen									X	
13	Kappeln		X								
14	Kiel							X			
15	Leck								X		
16	Lübeck	X									
17	Neumünster							X			
18	Neustadt/Hol	X									
19	Norderstedt									X	
20	Plön							X			
21	Preetz							X			
22	Ratzeburg										X
23	Rendsburg		X								
24	Schleswig		X								
25	Appen									X	

Table 11. Optimization Output for 30 Minutes' Commuting Time.

The commuting costs associated with this optimization output are EUR 77,883.85. This is significantly higher (2.3 times) than the costs of the status quo and even 3.1 times higher than the optimization after merging the branches. If we assume, however, that each officer in these 10 offices can lecture both on topics, we obtain 1,140 lectures, on average. The result of the

lecture value function in this alternative is 0.45, while we also have a 0.5 from the visitors value function. Thus, the overall effectiveness of this model is $0.45 + 0.5 = 0.95$; much higher than the alternatives and the status quo. Remember, however, that this option is also much more expensive.

Expanding the accepted commuting time to 90 minutes (one-way) reduced the number of offices from three to one office in Kiel, from where all other cities are served. This reduces the expenditures to EUR 11,785.27 only. This means, however, that only one officer would serve the whole state of Schleswig-Holstein. We consider this area as being too large for a single officer to handle because of the size of the target group anticipated in Table 1, so we do not regard this solution any further.

2. Number of Officers

Increasing the number of officers up to five in the last-mentioned scenario above (90 minutes commuting, one office in Kiel), however, could be an option if we extended the commuting time to 90 minutes one-way. The expenditures for this would be EUR 23,793.87, which is even cheaper (EUR 1,320.66 less, including the extra officers) than the optimization output with a 60-minute driving constraint—presuming that all officers are able to lecture on both topics. The overall effectiveness of this model would be 0.508. This model would create a center of excellence in one city and the attached officers would swarm out from there, “bee-like,” to address the target group. We would completely lose, however, the personal contact with the teachers in the schools that often create a relationship once they know “their” officer. Additionally, we have some doubts that the two recruiters (which we assumed to be working in each recruiting office) will be able to deal with the incoming applications and visitors within an acceptable time frame. Thus, we would have to employ more recruiters (costing EUR 2,211.34 each), which raises the costs. From our experience, we would need at least six recruiters to work on incoming applications and visitors. This

would raise the costs to EUR 32,639.23. This is still 4.5% cheaper than the status quo and might be an option for the decision maker.

Finally, we examine the question of what happens if we add a second officer to the offices, still assuming that both officers are able to lecture on both topics. Having two officers in one office would mean that we could raise the number of lectures to 228 per office, on average, which would mean an increase in effectiveness. Personnel costs, however, would also increase by the amount of an officer's salary (EUR 3,002.15) per office; thus, increasing the expenditures for personnel to EUR 10,426.98 per office. Commuting costs, however, would be the same as in the alternative, where one officer is able to lecture on both topics. This is because the two officers can now divide the area of responsibility and there is no need for both of them to visit every city (such as in the case where the specified topics are assigned to one officer). We display the optimization results from this scenario in Table 12. The layout of this table is the same as in Table 11.

ID		Eutin	Schleswig	Appen
1	Ahrensburg			X
2	Bad Schwartau	X		
3	Bad Segeberg	X		
4	Brunsbüttel			X
5	Eckernförde		X	
6	Elmshorn			X
7	Eutin	X		
8	Flensburg		X	
9	Heide		X	
10	Husum		X	
11	Itzehoe			X
12	Kaltenkirchen			X
13	Kappeln		X	
14	Kiel	X		
15	Leck		X	
16	Lübeck	X		
17	Neumünster	X		
18	Neustadt/Hol	X		
19	Norderstedt			X
20	Plön	X		
21	Preetz	X		
22	Ratzeburg	X		
23	Rendsburg		X	
24	Schleswig		X	
25	Appen			X

Table 12. Optimization Output with Two Officers per Office
Lecturing on Both Topics.

As we see, opening offices in Eutin, Schleswig, and Appen produces total expenditures of EUR 34,120.98. This option appears to be slightly cheaper (EUR 53.48; 0.1%) than the status quo. Since the chosen cities already harbor offices, we do not need to open new ones there. We face moving costs for the other offices, however, of EUR 25,000. Assuming the new structure would have started in January 2013, we cannot recover these costs over the assumed life cycle (until the end of 2025)—it would take about 39 years to recover the moving costs. The overall effectiveness (including lectures and visitors to offices) of this model is 0.597 and, thus, close to (but a little less than) the status quo.

3. Comparison

As we see in this sensitivity analysis, changing the constraints results in significantly different results regarding costs, effectiveness, and the placement of the branch offices into cities. To give an overview, in Figure 7, we included the results from the sensitivity analysis in the cost-effectiveness matrix and we obtained the following picture. The layout is in accordance with the layout of Figure 6.

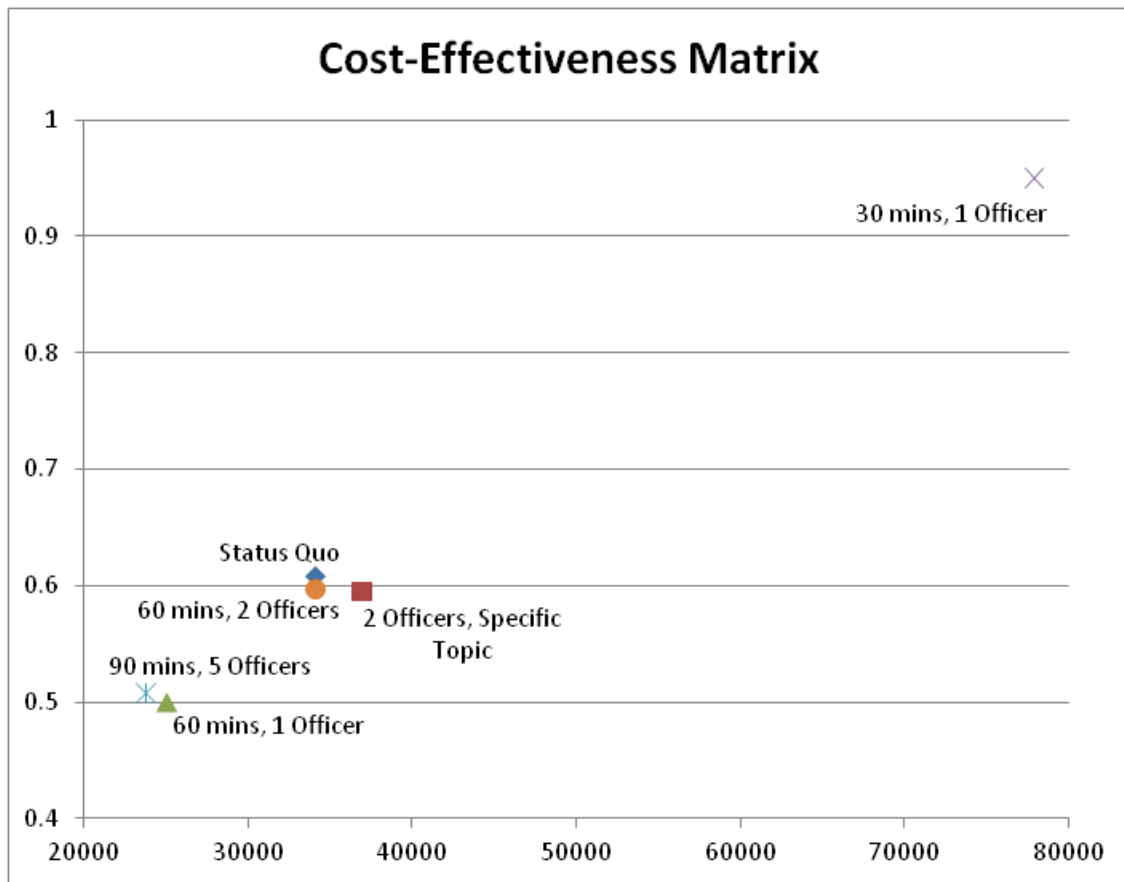


Figure 7. Cost-Effectiveness Matrix including Results from Sensitivity Analysis.

As we see, the option of prolonging the commuting time to 90 minutes and gathering five officers in a single branch center appears to be the cheapest solution. This solution is also slightly more cost-effective than the optimization result from the model above (one officer in each of the three offices, with a

60-minute commuting limit). We must keep in mind, however, that there are only two recruiters now handling all applications from a complete German state. We consider this number as being too low because we expect that those recruiters cannot handle all of the incoming applications and that there will be a long wait time to schedule an appointment for an individual talk. Thus, we would have to staff this center with more recruiters, which also means that we would raise the costs. This option, together with the original idea to staff the offices with one officer (who can lecture on both topics) with a 60-minute commuting limit, are a legitimate option if the decision maker is focused only on costs. Both alternatives return a decrease in effectiveness, which the decision maker should take into account.

Staffing the branch offices with only two officers who are able to lecture on both topics turns out to be only marginally less costly than the status quo (EUR 53.48); however, this alternative is also slightly less effective. We should also consider that we cannot recover the moving costs over the life cycle of this structure, so this alternative seems not to be an option.

We can gain a huge increase in effectiveness by limiting the commuting time to 30 minutes (and letting the officers lecture on both topics); however, we would more than double the current costs. Thus, we cannot recommend this option because we are also focused on saving money in the budget. The decision maker, however, might decide that the gain in effectiveness is worth the increase in costs.

The general question is how to decide between cost and effectiveness or, in other words: how do we decide between the lower expenditures of having only one officer who can lecture on both topics and the more expensive option of two officers lecturing on their specific topic and being more effective. As shown in the beginning, the German population and, with it, the target group, is declining. For the future, this means that the German armed forces will compete more and more with the economy for talented personnel and this competition will get more intense in the future. Thus, the German armed forces are well advised to focus

more and more on effectiveness instead of expenditures (although it is different now) in order to capture “the good ones.” In the distant future, we might be forced to execute the option of one officer per office with a 30-minute commuting time (costing almost EUR 80,000 monthly) to cover the needs of the armed forces, but presently we are in the fortunate position of not having to draw on this alternative. This philosophy, however, guided our thoughts and recommendations, showing that the status quo is the best alternative now.

V. CONCLUSIONS AND RECOMMENDATIONS: GERMANY

In the preceding chapters, we discussed the possible benefits of merging the recruitment branch and the political information branch of the German armed forces.

The recruitment branch focuses on finding applicants for a military career. To do this, the branch approaches young men and women ages 16 to 24. These young people are addressed about career opportunities in the armed forces at exhibitions and especially in lectures at school, where they are invited.

In contrast, officers of the political information branch lecture in schools about issues of security policy, including its socio-cultural aspects. They, too, mainly address pupils aged 16 and above. Thus, both branches, although not related to each other, focus on the same target group.

The problem arising from addressing the target group at schools for these different lectures is that teachers invite either one or the other officer. Thus, the lecture of one issue at a certain school automatically closes the door for the lecture of the other issue for some time. This is because while the armed forces are accepted in Germany, they are not perfectly admired. Today's teachers often belong to the "68" generation that is principally against any armed forces. Hence, it is difficult for any of the officers to enter a school, but almost impossible for both officers to show up within a certain time of one another. Furthermore, as laid out initially, the German armed forces are facing a significant reduction of about 26% and must reduce their budget.

Facing these problems, we gave birth to the idea of merging the recruitment branch and the political information branch to one unified branch, where the officers can lecture on both recruitment and security policy issues. A second idea was to merge the branches, but also to keep the tasks within the branches divided, which means having specialized lecturers as currently exists.

The overall goal is to raise the effectiveness of the German recruiting and political information branch.

In order to reach this goal, we defined two major objectives:

- Minimize expenditures
- Maximize target group contacts

The first objective, minimize expenditures, was then broken down into

- Minimize ineffective offices
- Minimize expenditures on office rent
- Minimize personnel
- Minimize the amount spent on commuting

As explained earlier, we do not need to worry about ineffective offices in the area, even when maintaining the status quo. Although there is a significant decline in the target group in Schleswig-Holstein of 23.43% until the year 2025, the absolute numbers still justify the presence of the recruitment offices with the same amount of personnel. We have no information about the target group development after 2025.

Similarly, the second objective was separated into

- Maximize lectures
- Maximize exhibitions
- Maximize visitors to offices
- Maximize media presence

As discussed previously, we did not regard the media presence because advertisements are centrally coordinated and the number of ads (radio, television, and newspapers) is assumed to be the same for all alternatives. The same is true for exhibitions that are centrally coordinated. For exhibition booths, we explained that the final decision to put them up at a school to accompany recruiting lectures is made by the school's principal and that the lecturing officer usually cannot influence it. To maximize these exhibitions, however, we strongly

encourage trying to put up a booth at a school in order to catch the pupils of the target group that did not attend the lecture.

After defining the goals and objectives, we then started to analyze the status quo. In the actual setting, we find four recruitment offices and four political information offices in Schleswig-Holstein, each run by one officer (accordingly, we have eight officers in this region). These eight officers produce expenses on commuting and rent of EUR 10,830.98 without personnel expenses and EUR 34,174.46 with personnel expenses, respectively.

In order to perform the cost-benefit analysis, we used optimization modeling to find the optimal solution for possible office locations after merging the recruitment branch and the political information branch. First, we identified the 25 cities in Schleswig-Holstein that the officers serve, leaving out the small villages in the catchment area. Then, we calculated the distances and commuting times, as well as the commuting costs between each city, and displayed them in a matrix for later use inside the optimization model.

After programming the matrices, the objective function, the constraints, and the formulas in GAMS, we were able to solve the optimization model and to vary some assumptions and constraints (sensitivity analysis).

The first optimization model returned the cost associated with the assumptions that one officer is able to lecture on security policy and recruiting issues. There was a 60-minute commuting limit to any city within the area of responsibility. It turned out that we would open three branch offices and that we would produce expenditures of EUR 25,114.53 (–26.52% of the status quo costs). This would also imply, however, a reduction in effectiveness from 0.608 to 0.500.

The second model had the same restrictions on commuting, but we staffed the branch offices with two officers, who would lecture in their specific topics. This alternative is 8.1% more expensive than the status quo and also slightly less effective (–2.1%). Thus, this model is not an option.

Starting the sensitivity analysis, we first varied the constraints of the commuting times. Reducing the commuting time to 30 minutes would increase the cost by 228%, because we have to open 10 branch offices and encounter significant personnel costs; however, this option also increases effectiveness by 156%. Although we cannot recommend this option (considering the need to save money), the decision maker could choose this scenario in order to capture the increase in effectiveness. By doing so, the decision maker would have to accept the increase in expenditures.

Increasing the commuting times, on the other hand, would mean that we opened a single center of excellence for security policy and recruiting in the city of Kiel. With expenditures of EUR 23,793.87 (by employing five officers there that can lecture on both topics) this is the cheapest alternative (–30.3% compared to the status quo). As we explained earlier, we doubt that the two recruiters will be able to deal with the incoming applications and visitors within an acceptable time frame. Thus, we would have to employ more recruiters (costing EUR 2,211.34 each), which raises the costs. From our experience, we would need at least six recruiters to work on incoming applications and visitors. This would increase the costs to EUR 32,639.23. This is still 4.5% cheaper than the status quo and might be an option for the decision maker. We must also consider, however, that we have only one center for the whole state. We cannot assess how many applications and visitors we might lose because the branch is not visible any more. Furthermore, our reputation might also suffer. All of these are losses that we cannot monetize; however, we are convinced that a center of excellence like this has to result in higher advertising costs (to equal the loss of visibility). Thus, this option can turn out to be more costly than the status quo and we cannot recommend it.

Finally, we looked at the outcome when we allowed two officers per office to lecture on both topics (with a 60-minute commuting limit). This option is 0.2%

cheaper than the status quo, but it is also 1.8% less effective. In this scenario, we cannot recover the moving costs of EUR 25,000 over the life cycle of this model. Thus, we do not recommend it.

With the data we had available for our optimization model, we recommend maintaining the status quo. Although we did find two alternatives that are less expensive than the status quo, these alternatives involve a reduction in effectiveness. The decision maker could opt for one of these alternatives, but since we are also concerned about effectiveness with the philosophy we stated above, we have to recommend the status quo because it returns the most effectiveness within a reasonable cost.

With additional data, however, our optimization results could change. For this analysis, we only regarded the people actively working with the target group. The branches also have many staff for administrative purposes only (numerous O-5s and O-6s), but the current numbers and pay grades were not provided to us. Merging the branches would also mean that we could reduce this staff (and not only the soldiers working with the target group) and we would save more on personnel costs. Considering these expenditures (and possible savings) could change our optimization results. Since this data was inaccessible to us, this question would have to be part of some further research.

Another issue that we want to discuss in this section is the question of the statistical value of life and the probability of being involved in an accident, especially in a severe accident, where the statistical value of life could influence the outcome of our analysis. According to Mussler (2005), the statistical value of life in Germany is, on average, EUR 1.65 million (EUR 1.72 million for males and EUR 1.43 million for females). There is no statistic, however, that tells us maximum probability of being involved in a traffic accident with respect to the hours driven. The reason for this is that every road user can influence this probability only by his or her behavior (aggressive or defensive driving, fast or slow driving, crossing the street without caring, and many, many other variables). Thus, contrary to playing the lottery where the outcomes cannot be influenced

and are thus independent, we cannot refer to a statistic that helps us evaluate the model. To obtain an idea of the general probability of having a traffic accident in Germany, however, we can divide the total number of accidents (2,361,457; Wikipedia, 2011) by the total number of registered cars (51.7 million; Federal Motor Transport Authority, 2012). We obtain a result of 0.0457, which means that the probability of being involved in a traffic accident in Germany in any given year is 4.57%. The probability of being involved in an accident with a fatal outcome is the number of people that died in a traffic accident (389; German Traffic Security Council, 2011) divided by the total number of accidents. The result is 0.0002, or 0.02%. The combined probability of being involved in an accident AND dying in this accident is thus $0.0457 * 0.0002 = 0.00000914$ (or 0.0009%). This is the probability for the standard commuter. Winkelmann (2010) calculated that the average commuter in Germany drives 30 minutes to work and back, which means one hour of commuting every day. Assuming that a year has 365 days and we deduct 52 weekends (=104 days), average days of leave from work (30; Deutschland mit 30 Urlaubstagen..., 2004) and public holidays (eight plus a varying number of state internal holidays), we obtain about 223 work days and, accordingly, 223 hours of commuting for the average commuter. Dividing the above-calculated probability of 0.00000914 by 223 returns the desired probability to be involved in a fatal accident per hour of driving, which is 0.0000000409865 (0.0000041%). Now we can easily calculate the accident probability for each office with respect to their commuting necessities, but this appears to be meaningless since any given officer would have to commute 243,902 hours (or 27.8 years) nonstop to have a 1% chance of being involved in a fatal accident. Because of this vanishing small probability, we decided not to include the probability of an accident and the statistical value of life in our model, since it does not affect the outcomes.

As we explained above, we recommend maintaining the status quo. This recommendation is mainly driven by our philosophy that we have to focus more on effectiveness than on costs, due to Germany's declining population and the

resulting competition with civilian firms (“war for talents”). We found less expensive models (with reduced effectiveness) and more effective models (that are much more expensive) that are feasible. The decision maker, however, has to make a trade-off between costs and effectiveness, since we were not able to provide a clearly superior solution. Additionally, we recommend further research by including the expenditures for the administrative staff of the current branches in the model to evaluate if our optimization outcomes change.

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VI. IMPLEMENTATION OF THE MODEL IN SAUDI ARABIA

In this chapter, we are going to implement the optimization model we developed and discussed in the previous sections to Saudi Arabia. Although we built the original model to merge two different branches in Germany and to find a new optimal structure, we believe that we can use the model to set up a new recruitment branch in Saudi Arabia. We also believe, however, that we have to adjust the model in order to fit it to the new situation. As we explained previously, we are going to limit the evaluation to only one Saudi Arabian province—Makkah. Employing the model to the whole of Saudi Arabia would only enlarge the number of cities that we would have to consider, but it would not improve the quality of the evaluation.

A. BACKGROUND

Until 2013, the Saudi Arabian armed forces did not have an organized military recruitment branch to carry out normal recruiting efforts. Military recruiting offices in Saudi Arabia are more like processing offices for the applicant to complete the required administrative procedures in order to join the military. The military is highly recognized throughout the population and young men volunteer in large numbers to serve in the armed forces. Thus, the Saudi military did not need to rely on a recruitment organization in order to obtain their planned end-strength. The status quo is therefore a situation without any recruiting organization (and without any recruiting expenses).

During the last five years, however, competition for the targeted pool of applicants increased, which we anticipate will result in a decline in accessions. Now an increasing number of colleges and the armed forces are competing for the same young people. The decision to implement a recruiting branch into the armed forces to ensure the achievement of end strength should be taken as soon as possible. Since recruitment is new to the military, the Ministry of Defense was tasked with implementing a successful recruitment system from another country.

The German recruitment system is one possible candidate because it is comparably easy and straightforward, compared, for example, with the system in the United States. In this chapter, we are going to use the optimization model from Chapter IV to find the best location for recruiting offices in the Saudi province of Makkah.

Makkah is a province in western Saudi Arabia, bordering the Red Sea. It encompasses an area of approximately 300,000 km² and has a population of approximately six million people. About 12.9% of the male population in Saudi Arabia is between 15 and 24 years old (Central Department of Statistics & Information, 2009). Since we do not have specific data for Makkah, we assume that this percentage also applies to this particular province. Hence, in Makkah we expect about 1,134,000 young people in the age of the target group. About 80% of the population is living in the cities. Makkah is marked by a Bedouin economy (nomads) due to the desert. Agriculture is only possible in some oases.

B. OPTIMIZATION MODEL FOR SETTING UP A RECRUITMENT ORGANIZATION

As laid out in Section A, a well-defined recruitment organization is currently nonexistent in the Saudi military. Thus, we first need to identify which cities in Makkah we can consider to house a recruitment office. Although Makkah is about 19 times larger than the German state of Schleswig-Holstein, we decided to consider only eight cities (compared to 25 in Germany). These are mainly those cities where we find about 80% of the population. The sheer size of Makkah, however, shows that we have to amend some assumptions we made for the German model and that we have to adjust the model accordingly. The eight cities, their location, and their ID number are displayed in Figure 8.



Figure 8. Possible Cities for a Recruitment Office, their Location, and ID Number in the Saudi Arabian Province of Makkah.

1. Decision Variables

The objective is to minimize expenses for the new recruitment branch in Saudi Arabia (exclusively in Makkah). In order to do that, we identified the eight significant cities in Makkah, where the majority of the target group lives. This list thus displays the possible locations of the individual offices. Since we want to minimize the total expenditures, the question is in which of these cities an office of the new recruitment branch should be located. Thus, the first set of decision variables is associated with the eight selected cities; we use j to index the possible office locations. For simplicity, we coded them with numbers 1 through 8. Additionally, we used i to index the destination cities. For simplicity, they are also coded with numbers 1 through 8. All decision variables have to be binary, where a 1 indicates the presence of an office or service and a 0 otherwise.

C_j denotes the decision if we locate an office in city j , and

$S_{i,j}$ denotes that city i served by an office in city j

Furthermore, we have to introduce the following set of parameters in order to set up the objective function:

R_j denotes the rental costs for operating an office in city j ;

$D_{i,j}$ denotes the commuting costs from an office in j to city i ;

P_j denotes the personnel costs for operating an office in city j ;

$T_{i,j}$ denotes the commuting time from an office in j to city i ;

L denotes the time limit for commuting; and

$V_{i,j}$ denotes the statistical value of life at risk when commuting from an office in j to a city i .

2. Objective Function

First, we constructed a distance matrix between each of the selected cities as well as a travel time matrix (see Tables 13 and 14, respectively).

ID		1	2	3	4	5	6	7	8
1	Makkah	0	85.5	89.7	351	443	251	308	195
2	Jeddah		0	170	365	523	330	393	160
3	Ta'if			0	366	356	161	223	286
4	Al Qunfudhah				0	505	310	409	514
5	Ranyah					0	232	149	623
6	Turbah						0	96	442
7	Al Khurmah		Distance between cities in km					0	495
8	Rabigh								0

Table 13. Distance Matrix (distances in kilometers).

ID	1	2	3	4	5	6	7	8
1 Makkah	0	67	67	275	341	191	240	127
2 Jeddah		0	125	284	397	246	299	110
3 Ta`if			0	281	272	122	171	200
4 Al Qunfudhah				0	327	247	322	380
5 Ranyah					0	176	115	466
6 Turbah						0	74	314
7 Al Khurmah							0	375
8 Rabigh								0

Table 14. Travel Time Matrix (travel time in minutes).

With a closer look at the travel time matrix, we can see easily that we have to amend the assumption concerning the commuting times from the German model. In that model, we assumed that no recruiter should travel more than 60 minutes to any city within his/her area of responsibility. Table 14 reveals that the shortest commuting time between cities is 67 minutes. This means that every potential city would need to house a recruitment office because the commuting times are too long. Extending the acceptable commuting time to 90 minutes would only capture the trip between Makkah and Jeddah or Makka and Ta`if (or vice versa). Extending the commuting time to 120 minutes, however, would give enough variation to use optimization modeling to find the best location for recruiting offices. This commuting time is justified by the less regulated and strict labor laws (compared to Germany) that make longer workdays possible and because many Saudis spend more than two hours (one-way) to commute to work (although the average commuting time to work in Saudi Arabia is 50 minutes).

In a third step, we applied a monetary value to commuting. Unfortunately, we do not find a standard amount like in Germany that we can use to calculate the costs for commuting. We thus decided to use the German EUR 0.42 per kilometer to obtain a comparable value. We are aware that gas in Saudi Arabia is less expensive than in Germany. While Germany is using fuel-efficient cars (like Smart or Volkswagen Golf), however, the Saudi military has to use bigger cars (often 4x4 off-road vehicles) that are better suited for the desert environment and

streets that often have big holes in the concrete. These cars consume more gas than the cars in Germany. For these reasons, we do not adjust the standard amount for commuting to the lower gas prices and regard the EUR 0.42 as adequate. The corresponding matrix is displayed in Table 15.

ID		1	2	3	4	5	6	7	8
1	Makkah	0.00 €	35.91 €	37.67 €	147.42 €	186.06 €	105.42 €	129.36 €	81.90 €
2	Jeddah		0.00 €	71.40 €	153.30 €	219.66 €	138.60 €	165.06 €	67.20 €
3	Ta`if			0.00 €	153.72 €	149.52 €	67.62 €	93.66 €	120.12 €
4	Al Qunfudhah				0.00 €	212.10 €	130.20 €	171.78 €	215.88 €
5	Ranyah					0.00 €	97.44 €	62.58 €	261.66 €
6	Turbah						0.00 €	40.32 €	185.64 €
7	Al Khurmah	All costs in EUR.						0.00 €	207.90 €
8	Rabigh	Calculation: Distance between cities in kilometers							0.00 €
		multiplied by the standard amount per kilometer.							
		Standard amount per km:				0.42	EUR		

Table 15. Costs for Commuting between the Cities.

In order to obtain a good idea about the commuting costs, we assume, like in the German model, that each city is visited by a recruiter according to its number of relevant schools (for Saudi Arabia: high schools). This means we assume that if a city has 90 schools, the recruiter commutes to this city 90 times and back (thus, doubling kilometers driven and costs). We display a list with the number of schools in each city below.

ID	Number of High Schools
1 Makkah	90
2 Jeddah	122
3 Ta`if	90
4 Al Qunfudhah	39
5 Ranyah	10
6 Turbah	10
7 Al Khurmah	8
8 Rabigh	7

Table 16. Number of High Schools in Makkah.

Commuting costs, although a big cost driver, are not the only costs we have to consider for the optimal location of the recruiting offices. As in Germany, we have to rent office space, namely in the cities of Al Qunfudhah, Turbah, Al Khurmah, and Rabigh. Although these cities are comparably large, compared to the other cities in the province, we must assume higher amount of rent (EUR 10,000) in each city due to the high rent levels.

Second, we are going to consider the personnel costs (one officer per office location) as an integral part of the model. Here, we assume that the recruiter in Saudi Arabia has the pay grade of an O-4, earning a base pay of EUR 3,000. We chose this pay grade to respect the sheer size of the area of responsibility, the size of the target group, and the risk that arises from commuting between the different cities. According to the Saudi Arabian Ministry of Finance, however, people working in remote areas obtain a 25% increase in salary as incentive pay. Thus, officers working in Al Qunfudhah, Ranyah, Turbah, or Al Khurmah earn EUR 3,750, while all others are paid with base salary (EUR 3,000).

Finally, we have to review the statistical value of life in the Saudi Arabian model. Referring to Al-Ghamdi (year of publication unknown), the probability of having a fatal road accident in Saudi Arabia is 2.6% per year. Assuming that a year has 365 days and subtracting the weekends (104 days) and an average of 20 days of holiday per year, the work year in Saudi Arabia has 241 days. Since the average commuting time in Saudi Arabia is 50 minutes (one-way), the average commuting time is 100 minutes per day or 24,100 minutes per work year. Dividing the 2.6% by 241 workdays returns an average probability of being involved in a fatal accident of 0.0108% per day (or per 100 minutes of commuting). Taking the total amount of minutes for commuting from one city to the other (according to the number of schools), multiplying it by 2 (for the return), and dividing the result by 100 returns the higher chance of a fatal accident for a recruiter for commuting compared to the average Saudi Arabian. Multiplying this result by EUR 178.20 ($0.0108\% \cdot \text{EUR } 1,650,000$ – since we do not have an

amount for Saudi Arabia we assume the same amount as in Germany – 1.65 million Euros) returns the value that is at risk when a recruiter drives once to each school within his/her area of responsibility and returns to his/her office.

This calculation returns the following values for the life at risk, shown in Table 17.

ID		1	2	3	4	5	6	7	8
1	Makkah	0.00	21,490.92	21,490.92	88,209.00	109,379.16	61,265.16	76,982.40	40,736.52
2	Jeddah	29,132.14	0.00	54,351.00	123,485.47	172,618.78	106,962.77	130,007.59	47,828.88
3	Ta'if	21,490.92	40,095.00	0.00	90,133.56	87,246.72	39,132.72	54,849.96	64,152.00
4	Al Qunfudhah	38,223.90	39,474.86	39,057.88	0.00	45,451.69	34,332.01	44,756.71	52,818.48
5	Ranyah	12,153.24	14,149.08	9,694.08	11,654.28	0.00	6,272.64	4,098.60	16,608.24
6	Turbah	6,807.24	8,767.44	4,348.08	8,803.08	6,272.64	0.00	2,637.36	11,190.96
7	Al Khurmah	6,842.88	8,525.09	4,875.55	9,180.86	3,278.88	2,109.89	0.00	10,692.00
8	Rabigh	3,168.40	2,744.28	4,989.60	9,480.24	11,625.77	7,833.67	9,355.50	0.00
Statistical Value of Life at risk when commuting (and return) according to # of schools in city									

Table 17. Statistical Value of Life for Commuting between the Cities.

Taking all those different costs, we obtain the following objective function:

Minimize Commuting Costs + Rental Costs + Personnel Costs + Life at Risk

$$\sum_{i=1}^8 \sum_{j=1}^8 D_{i,j} S_{i,j} + \sum_{j=1}^8 R_j C_j + \sum_{j=1}^8 P_j C_j + \sum_{i=1}^8 \sum_{j=1}^8 V_{i,j} S_{i,j} \quad (2a)$$

By minimizing this function, we expect to find the optimal solution; thus, the location of offices from which the expenses for commuting are the lowest.

3. Constraints

First, we have to ensure that we only serve a city if an office exists in C_j that is able to serve the city C_i . The corresponding algebraic constraint is

$$\sum_{i=1}^8 S_{i,j} \leq M C_j \quad \forall j = 1-8, \quad (2b)$$

where M is a very large number that does not constrain any further.

The possible locations of offices might result in two or more offices being able to serve the same city, depending on the commuting time constraint below.

We want to ensure, however, that only one office is responsible for every city to avoid this “double serving.” Thus, the according algebraic constraint is

$$\sum_{j=1}^8 S_{i,j} = 1 \quad \forall i = 1-8. \quad (2c)$$

Third, we want to ensure that we do not exceed a certain commuting time to drive from one city to another (one-way). Using our experience, as well as statements from several recruiting officers, we set this limit L at 120 minutes of driving. This time pays respect to the conditions in Saudi Arabia and allows enough time for the recruiting officer to arrive at his/her destination. This limit also pays respect to the fact that the recruiting officer might have to visit his/her office before leaving. Work time starts either with entering the office or, if the recruiting officer starts to the destination city from home, with leaving for the destination city. Thus, the corresponding algebraic formulation of this constraint is

$$T_{i,j} S_{i,j} \leq L \quad \forall i = 1-8, j = 1-8, \quad (2d)$$

where L is set at 120.

Finally, we have to ensure that the decision variables are all binary. Since these variables are all binary, we do not need to account for nonnegativity.

$$C_i \in \{0,1\} \quad \forall i \quad (2e)$$

$$S_{i,j} \in \{0,1\} \quad \forall i,j. \quad (2f)$$

4. Results of the Optimization Model

After optimizing the model, we see that the constraints are optimally satisfied and we find a feasible solution to the problem. Following the optimization results, we open offices in the following cities, as indicated in Table 18.

ID	Makkah	Jeddah	Ta`if	Al Qunfudhah	Ranyah	Turbah
1 Makkah	X					
2 Jeddah		X				
3 Ta`if			X			
4 Al Qunfudhah				X		
5 Ranyah					X	
6 Turbah						X
7 Al Khurmah						X
8 Rabigh		X				

Table 18. Output Objective Function for the Saudi Arabian Model.

We see that, except for Al Khurmah and Rabigh, we are going to open offices in every city, with a total minimum cost of EUR 46,690.09. This is the minimum cost we can achieve under the assumptions we made earlier in this section. For a graphical display of office locations please refer to Figure 9 (cities with offices are underlined).



Figure 9. Location of Cities with Recruitment Offices.

Currently, we have no experience on the duration of recruitment talks or lectures in front of the target group. Both have to be prepared first and do not

exist yet. We can assume, however, that their length will be comparable to the length of the lectures and talks in Germany. Since we do not have a status quo with which we can compare our optimization outcome, it is not possible to calculate the effectiveness of the lectures. Furthermore, we have to assume that the number of lectures remains the same throughout the alternatives discussed in the sensitivity analysis below. Thus, the optimization is limited to a pure cost comparison (personnel, commuting, rent, and life at risk).

C. SENSITIVITY ANALYSIS

After the clear result in Section VI.B, we want to discuss the question of what happens if one of the major cost drivers changes. In this section, we are going to change the major cost drivers in the model: personnel costs, rent expenses, statistical value of life, and the commuting assumption.

First, we are going to change the personnel costs. So far, we assumed that each recruitment office would be managed by an officer in pay grade O-4, who earns a base pay of EUR 3,000. We chose this pay grade to respect the sheer size of the area of responsibility, the size of the target group, and the risk that arises from commuting between the different cities. The Ministry of Defense, however, might choose only to employ officers at the pay grade of O-3, with a base pay of EUR 2,700, in order to save money. Nevertheless, they might as well choose to raise the pay grade to O-5 (base pay EUR 3,300) in order to recognize the importance of the recruiting mission. Please recall that the recruitment officers may expect a 25% raise in base pay as incentive to work in remote areas.

By raising the pay grade to O-5, as well as lowering the pay grade to O-3, we return exactly the same results already displayed in Table 26. Both suggest opening recruiting offices in all cities except for Al Khurmah and Rabigh. The only difference to the optimization result above is that employing recruiters in the pay grade of O-5 will cost EUR 48,715.09, while employing recruiters in the pay grade of O-3 only costs EUR 44,665.09.

Again, we find that the optimization result does not affect the optimal outcome and the offices remain in the same cities. Please note that the total amount spent varies according to the reduced or increased salary. Thus, we can infer that the pay grade of an officer is not important for the optimal output and it is the Minister of Defense`s decision as to which pay grade he wants to employ in the recruitment organization since we cannot recommend a “best” pay grade.

Second, we are investigating what happens when the rent expenditures change. Please note that we need to rent office space in four cities only (each with EUR 10,000 rent expenditure) because we can use military installations in the remaining four cities. However, we examined the outcomes by lowering the rent to EUR 5,000 and by increasing the rent to EUR 20,000 and EUR 50,000, respectively. The optimal outcome displayed in Table 26 did not change; however, we find changes in the expenditures since we changed one of the cost factors, but the optimal location of recruiting offices remains the same.

Changing the commuting assumption is closely connected to changing the statistical value of life or, in other words, the value that is at risk per trip. Since both assumptions are so closely related (the risk per trip depends on the time spent commuting), we are going to investigate both together. We already know that reducing the time for commuting automatically reduces the risk value per trip and vice versa. From the commuting matrix, we already know that limiting the commuting time to 60 minutes only results in the need to have an office in every city (recall that the minimum distance between cities requires 67 minutes of travel time). We thus lowered the commuting time to 90 minutes only. We display the optimization outcome in Table 19 (offices are in columns, cities served are in lines).

ID	Makkah	Jeddah	Ta`if	Al Qunfudhah	Ranyah	Turbah
1 Makkah	X					
2 Jeddah		X				
3 Ta`if			X			
4 Al Qunfudhah				X		
5 Ranyah					X	
6 Turbah						X
7 Al Khurmah						X
8 Rabigh	X					

Table 19. Optimization Result with a 90-Minute Commuting Limit.

The optimization outcome under the 90-minute commuting restriction looks very similar to the first outcome. The only difference is that Rabigh now lies in the area of responsibility of Makkah (and not Jeddah). This little difference raises expenses by 19.95% (EUR 9,314.92) to EUR 56,005.01. Thus, lowering the commuting limit to 90 minutes is not cost effective.

Second, we increased the commuting time to 150 minutes (made it 30 minutes longer). The optimization outcome is shown in Table 20.

ID	Makkah	Jeddah	Ta`if	Al Qunfudhah	Ranyah
1 Makkah	X				
2 Jeddah		X			
3 Ta`if			X		
4 Al Qunfudhah				X	
5 Ranyah					X
6 Turbah			X		
7 Al Khurmah					X
8 Rabigh		X			

Table 20. Optimization Result with a 150-Minute Commuting Limit.

Table 20 shows the total expenditures that we encounter when raising the commuting limit to 150 minutes. We only need to open recruitment offices in five of the eight cities, producing costs of only EUR 40,165.72. This alternative is 13.97% (EUR 6,524.37 per month) cheaper than the optimization output under the 120-minute commuting assumption. Thus, this model is a good alternative to

the first model. It is now to the decision maker's discretion as to which model to choose. We recommend the third alternative, since it is the most cost-effective option. For this recommendation, we assumed equal effectiveness of these two models. We think this is reasonable because the difference between the models is the commuting time (+30 minutes in the third alternative). The recruiter can still address the same number of target groups, he/she just has to adjust his/her departing time from the office according to the commuting time. Although the commuting costs include the statistical value of life, extending the commuting time limit by 30 minutes returns the lowest expenditures. We are aware that this alternative is more demanding for the recruiting officers, since they have to drive one hour more (+30 minutes to and from the destination city). We think, however, that with respect to the sheer size of the areas and the lower risk of life, that this is an acceptable option. Alternatively, we would opt for the 60-minute commuting constraint.

D. SUMMARY

Applying the German optimization model to the Saudi Arabian province of Makkah required some amendments to and adjustment of the model. First, we needed to rethink the maximum time for commuting since the distances in Makkah are much larger than in Schleswig-Holstein. Second, we needed to implement the statistical value of life into the model because the probability of being involved in a fatal accident in Saudi Arabia is significantly higher than in Germany. We had to account for the risk that a recruiting officer faces when he/she is commuting within his/her area of responsibility.

After solving for the optimal outcome, we conducted a sensitivity analysis to see how this outcome changes when our assumptions change. During this analysis, we found that increasing the commuting limit by 30 minutes results in significantly lower expenditures than the optimization result we initially calculated.

Furthermore, opening a recruiting office in almost every city has advantages that we cannot monetize. One advantage is that each city has its

own recruiter. This recruiter can build personal relationships with important persons and institutions that are helpful for his/her mission. In addition, he/she is always available, even on short notice. Additionally, almost no applicant is forced to drive to a different city or wait until the recruiter is in town to talk to him/her. The applicants can simply walk in the recruiting office any time that is convenient for them. This service cannot be offered when a city has no recruiting office. All these points make the recruiter more effective. Taking these advantages and the results from above into account, we strongly recommend choosing the alternative shown in Table 20.

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LIST OF REFERENCES

- Al-Ghamdi. (n.d.). Road accidents in Saudi Arabia: A comparative and analytical study. Retrieved from http://www.google.com/url?sa=t&rct=j&q=al-ghamdi%20fatal%20accidents%20in%20saudi%20arabia&source=web&cad=2&cad=rja&ved=0CDUQFjAB&url=http%3A%2F%2Ffaculty.ksu.edu.sa%2FAl%2FAl%2FResearch%2FRoad%2520Accidents%2520in%2520Saudi%2520Arabia.pdf&ei=3Em9UIObKsqeiAKqrIDYBA&usg=AFQjCNH-VUOqILvABhNox3PIRJOdSo_hpg
- Balakrishnan, N., Render, B., & Stair, R. M. (2007). *Managerial decision modeling with spreadsheets* (2nd ed.). Upper Saddle River, NJ: Pearson/Prentice Hall.
- Beamtenbesoldung. (2012). Retrieved from <http://www.beamtenbesoldung.org/images/bund/bundesbesoldungstabelle-2012.pdf>
- Central Department of Statistics & Information. (2009). Population (15 years old and over) by administrative area and sex. Retrieved from http://www.cdsi.gov.sa/english/index.php?option=com_docman&task=cat_view&gid=207&Itemid=162
- Comparison between Germany and Saudi Arabia. (2010). Retrieved from <http://aysenurum.com/vergleich.php?iso1=SAU&iso2=DEU>
- Deutschland mit 30 Urlaubstagen weltweit auf Platz 2. (2004)., retrieved from <http://www.shortnews.de/id/545909/Deutschland-mit-30-Urlaubstagen-weltweit-auf-Platz-2>
- Federal Motor Transport Authority. (2012). Number of registered cars in Germany. Retrieved from http://www.kba.de/clu_007/un_124584/DE/Statistik/Fahrzeuge/Bestand/bestand_node.html?_unm=true
- Federal Statistical Office Germany. (2012). Die Bevölkerungspyramide. Retrieved from <https://www.destatis.de/bevoelkerungspyramide>
- German Traffic Security Council. (2011). DVUG-Statistik 2011. Retrieved from <http://www.dvr.de/aktuelles/sonst/3137.htm>
- Glicksman, A. M. (1963). *An introduction to linear programming and the theory of games*. New York: Wiley.
- Global Rates.com. (2012). Inflation Deutschland. Retrieved from <http://de.global-rates.com/wirtschaftsstatistiken/inflation/verbraucherpreisen/vpi/deutschland.aspx>

- Jugendoffiziere. (2012). Retrieved from <http://schleswig-holstein.jugendoffizier.eu/kontakt/>; (www.jugendoffizier.eu). website of the political information officers.
- LaCivita, C. (2011). GB4071: Economic analysis and defense resource allocation. Lecture Notes. Naval Postgraduate School.
- Ministry of Higher Education (2011). King Abdullah Scholarship Program (KASP). Retrieved from <http://www.mohe.gov.sa/en/studyaboard/King-Abdullahstages/Pages/introduction-a.aspx>
- Ministry of Higher Education (2012). High Education Statistical Center, Annual Reports. Retrieved from <http://www.mohe.gov.sa/ar/Ministry/Deputy-Ministry-for-Planning-and-Information-affairs/HESC/Ehsaat/Pages/default.aspx>
- Mussler, W. (2005). Hat ein Menschenleben einen Geldwert? Retrieved from <http://www.faz.net/aktuell/wirtschaft/oekonomie-hat-ein-menschenleben-einen-geldwert-1230638.html>
- Sachstand zur Neuausrichtung der Bundeswehr. (2011). Internal Paper. Distributed via e-mail to all German soldiers.
- Schnittker, U. (2011). *Jahresbericht der Jugendoffiziere der Bundeswehr. Ausgabe 2010*. Berlin: Ministry of Defense.
- Schulportaets. (2012). Retrieved from http://schulportaets.schleswig-holstein.de/portal/schule_suchen/
- Statistical Office Hamburg/Schleswig-Holstein. (2010). Population Development. Retrieved from http://www.statistik-nord.de/uploads/tx_standdocuments/A_I_3_j10.pdf
- Wikipedia. (2011). Traffic accident statistics for Germany. Retrieved from http://www.wikipedia.org/wiki/Straßenverkehrsunfall#Unfallstatistik_Deutschland
- Wikipedia. (2012). Holidays in Germany. Retrieved from http://de.wikipedia.org/wiki/Feiertage_in_Deutschland
- Winkelmann, U. (2010). Manche pendeln weit – Berufspendler im Ländervergleich, *Statistisches Monatsheft Baden-Württemberg 4/2010*. Retrieved from http://www.statistik-portal.de/veroeffentl/Monatshefte/PDF/Beitrag10_04_07.pdf

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